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Blots Out Fire
In Telephone Switch-Boards, Electric Light Stations, Street Railway Equipments, Subway Manholes, and all Electrical Apparatus.
...pliance Company,
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TELEPHONE SUPPLY COMPANY
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19 SOUTH CANAL STREET, CHICAGO.

This Adv. is Worth $1.00 To You
J. DONNELLY
If you mention this paper. If you will send a Postal Money Order for $2.00 we will send you a pair of Donnelly Steel Climbers and give you a $1.00 set of straps with pads. Each spur is OIL TEMPERED.
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CROSS ARMS
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ELECTRIC APPLIANCE COMPANY
Manufacturers of
EACO BELL TYPE TELEPHONES,
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AMERICA'S LARGEST ELECTRICAL SUPPLY HOUSE
92 & 94 West Van Buren Street, CHICAGO.

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STORAGE CELLS ARE THE BEST
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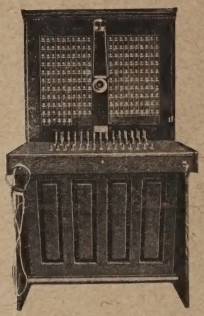

WE

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DON'T DE

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DO IT

No. 2
Just th
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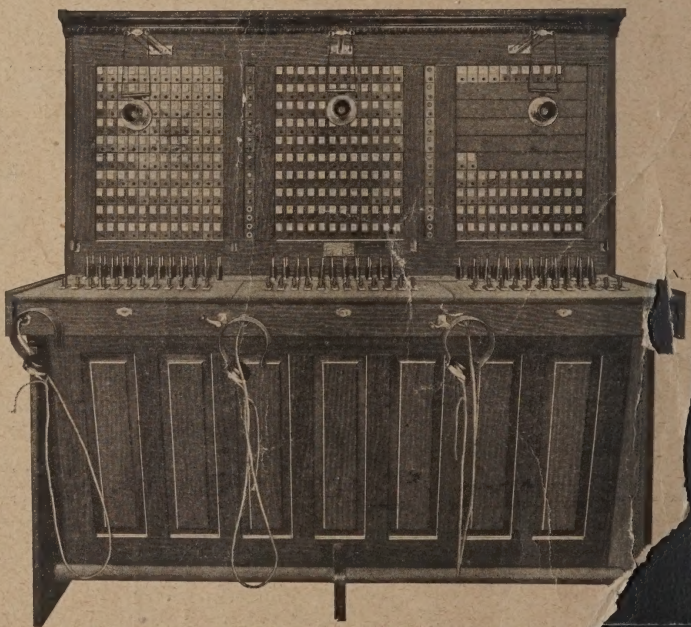
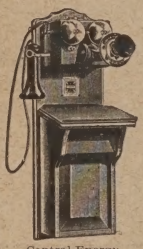
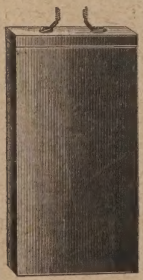
ELECTRIC FLASHLIGHT SWITCHBOARDS.





Central Energy Systems.



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The above cuts show our New Full Flashlight and Electric Light Clear-out S
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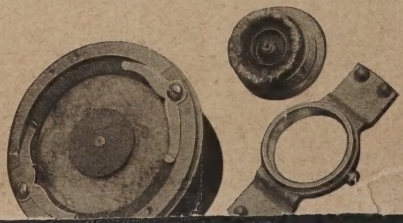

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Vol. 2, No. 6.

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1902 CHICAGO BRIDGING APPARATUS NOW READY.

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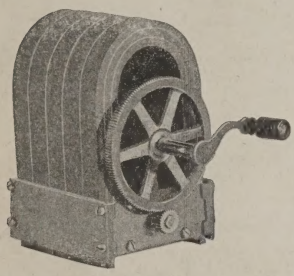
More Magnet Steel is used in this Generator than in any other five-bar Generator.



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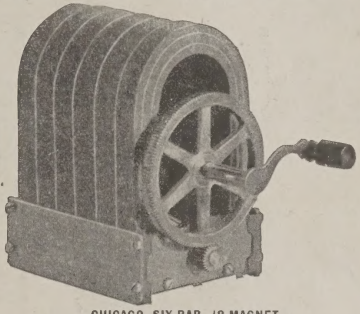

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In the matter of magnet steel both quantity and quality count. Quality is determined by the way the magnet steel is treated.

In the construction of magnets used on Chicago Bridging Generators the full benefit of lamination is secured. Further, small magnets can be more uniformly tempered and more thoroughly saturated with magnetism than large ones. It is, of course, more expensive to make a generator with laminated magnets, but the extra expense is justified by the superior degree of efficiency and durability.

This is only one of the many reasons why Chicago Bridging Generators have placed this factory at the head of the list in the production of Bridging telephones.

Samples will be submitted to demonstrate in actual service the claims we make for superiority.

We will appreciate your kindness if you will instruct us to send you a copy of the Bridging Book free of charge. It tells all about party line work, including organization, construction, installation and care. It is a valuable book and is the only up-to-date treatise on bridging work.

It is too expensive for indiscriminate distribution, but will be sent cheerfully to any one sufficiently interested to ask for it.

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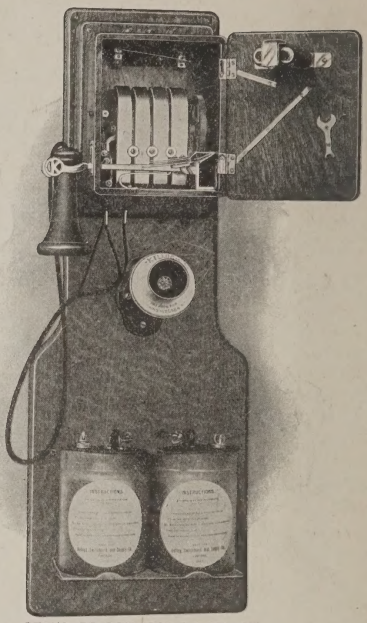
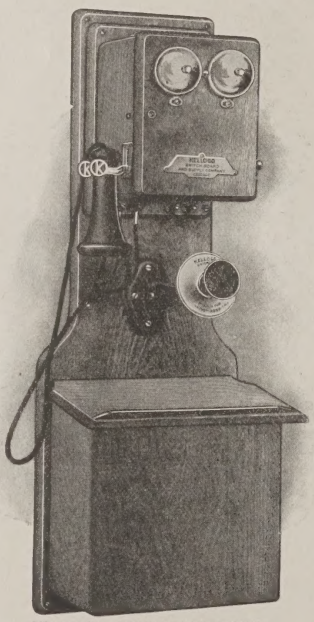


STANDARD BRIDGING TELEPHONE
(Open)



STANDARD BRIDGING TELEPHONE.

Are manufactured by this company at the rate of two thousand (2,000) per week, and each 'phone is equipped with a transmitter better than the "Bell Solid Back." The manufacturers stand ready to prove this statement. Kellogg Transmitters are guaranteed for five years.

KELLOGG WIDE BATTERY BOX BRIDGING TELEPHONE has the well-known KELLOGG TRANSMITTER, RECEIVER and HOOKSWITCH. Woodwork first-class; furnished in either oak, walnut or mahogany. Concealed cord transmitter arm.

All wiring is soldered without the use of acid and cannot become crossed or detached.

Compare the wiring of this telephone with that of any other manufacturer. The instruments are properly designed, properly made and properly tested.

Every Piece of Kellogg Apparatus is Backed by a Guarantee Worth the Price of Your 'Phone.

Increased Floor Space Enables Us to Make Prompt Shipment on all Telephone Apparatus.

KELLOGG
SWITCHBOARD & SUPPLY CO. CHICAGO.

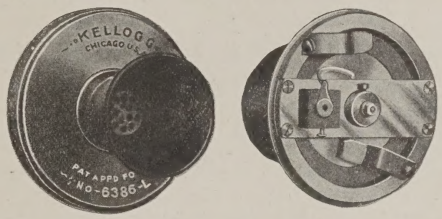
THE KELLOGG TRANSMITTER AND RECEIVER

GUARANTEED BY THE MANUFACTURERS

Not long ago the "BELL SOLID BACK" was held to be a standard of excellence in Telephone Transmitters. Now this statement is often heard: "As good as the **KELLOGG." WHY?** Because a new standard has been set. We say without hesitation and stand ready to prove it, that the

"KELLOGG" TRANSMITTER is BETTER than the "BELL SOLID BACK."

The Kellogg Transmitter gives powerful transmission as well as perfect articulation. The construction is very substantial. None of its parts are affected by moisture or by sudden changes in temperature. Built of best material by first-class mechanics.



Kellogg Transmitters are so near alike, as far as talking qualities are concerned, that an expert would not be able to tell one from another, except by the serial number stamped on the front of each transmitter.

They are fully guaranteed for five years.

KELLOGG RECEIVER AND HOOKSWITCH.

KELLOGG RECEIVER

combines efficiency, stability and strength, together with handsome appearance.

Is very sensitive. Responds perfectly to the weakest transmission of long-distance lines.

Has pure, hard rubber shell, which conceals all metal parts. Magnets are fastened to the shell by a cast metal bridge.

Has permanent adjustment. The shell alone in this receiver costs us two-thirds of the selling price of complete receivers of some of our competitors.

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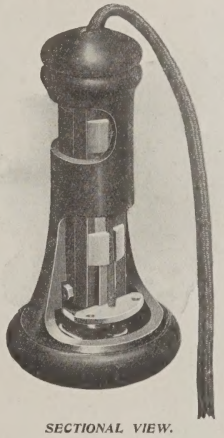
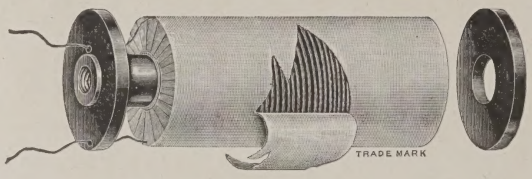


SECTIONAL VIEW.

KELLOGG

SWITCHBOARD & SUPPLY CO. CHICAGO.

ATTENTION



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FIRST—All Coils are wound by Automatic Machines, which make them uniform throughout as to wire, resistance and size.

SECOND—Our method of winding enables us to get more turns in a given space, and each turn being closer to the core makes a stronger and more efficient Magnet.

THIRD—Actual experience by Exchanges has proven that Varley Coils are less liable to burn outs, which fact alone is a great saving.

FOURTH—All Magnets are made complete for any make of Telephone or Switchboard, and can be easily installed by Inspectors.

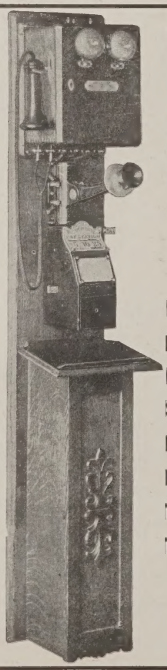
RINGER MAGNETS——SWITCHBOARD MAGNETS——INDUCTION COILS

Made any size and specifications with either **Insulated** or Bare Wire.

WRITE FOR PRICES AND CIRCULARS.

VARLEY DUPLEX MAGNET CO.

82 LAKE ST., CHICAGO. PHILLIPSDALE, R. I.



WESTERN TELEPHONE CONSTRUCTION CO.,

FACTORY: WINTHROP HARBOR, ILL.

OFFICES AND SALESROOMS: FISHER BUILDING. CHICAGO, ILL.

"WESTERN EXPRESS" PAY STATION LONG-DISTANCE TANDEM TELEPHONE.

NEW STYLE "WESTERN" DESK SET.

WE HAVE ONE OF THE LARGEST AND MOST COMPLETE FACTORIES IN THE UNITED STATES DEVOTED EXCLUSIVELY TO THE MANUFACTURE OF TELEPHONE APPARATUS.

LATEST UP-TO-DATE TYPES FURNISHED.

SMALLEST OR LARGEST SIZE EXCHANGES AND TOLL LINES THOROUGHLY EQUIPPED WITHOUT DELAY.

ALL APPARATUS GUARANTEED.

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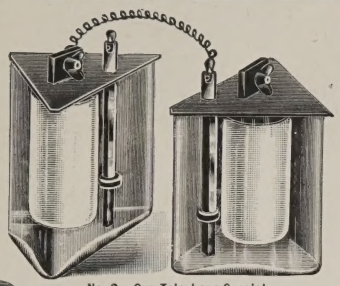
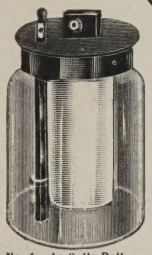
Something **NEW** for Telephones.

Will Fit Cabinets of Different Sizes.

Patent applied for.



No. 2. Our Telephone Special.



No. 1. La Salle Battery. (With Ordinary Laclanche Jar.)

FOR ALL PURPOSES.

Best Material,
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Most Economical.

La Salle Electric Co.,
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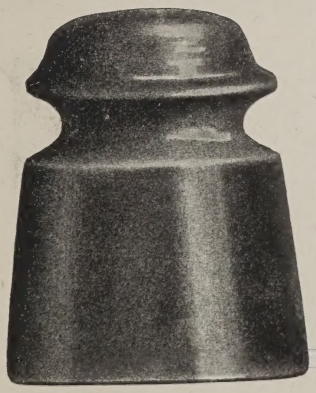

LOCKE
No. 6.

Porcelain Telephone Insulator.

WORTH YOUR WHILE TO KNOW

THAT THIS IS . . .

Stronger
Better Insulation } THAN
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MADE OF HIGHEST GRADE, ABSOLUTELY NON-ABSORBENT LOCKE PORCELAIN. PRICE IS RIGHT.

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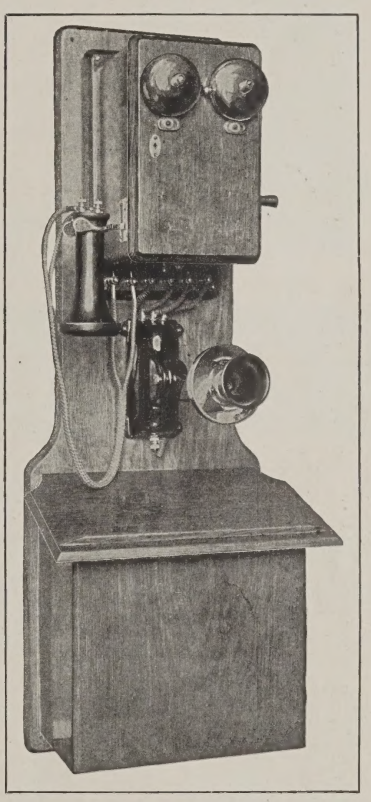

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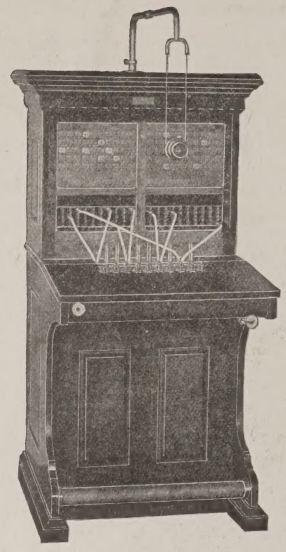
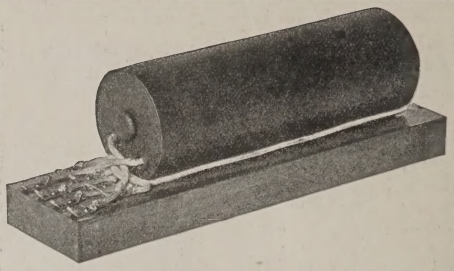


100-LINE BOARD

NORTH



REPEATING COILS

PERFECTLY BALANCED

CENTRAL BATTERY
and MAGNETO CALL

MULTIPLE SWITCHBOARDS

DIVIDEND PAYERS

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PURE PLATINUM POINTS
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TUBULAR DROPS AND
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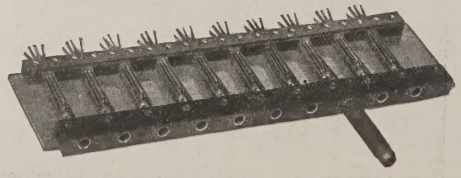
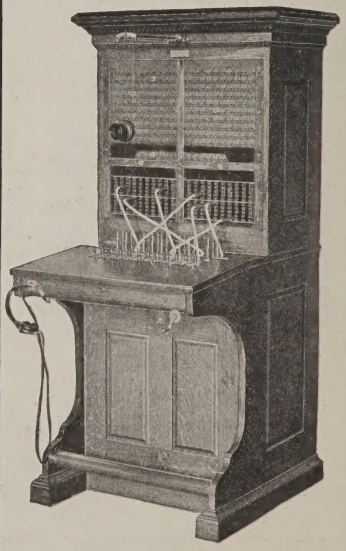
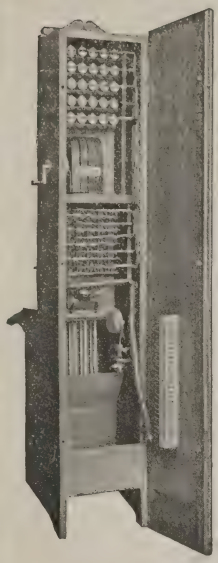


BOARDS



200-LINE BOARD



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WE MAKE A SPECIALTY OF

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OUR NEW DESIGN OF

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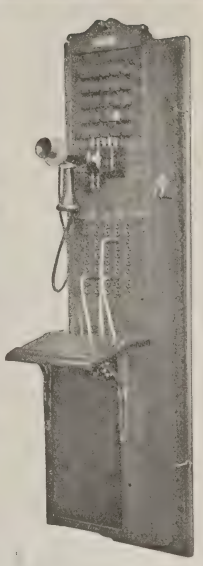
SYSTEMS



25 DROPS

SWITCH-BOARDS

10 DROPS

OUR MOTTO:

DURABILITY SIMPLICITY

FULL LINE OF

EXCHANGE EQUIPMENT TELEPHONES

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NORTH ELECTRIC COMPANY

CLEVELAND,

69-79 FRANKFORT STREET

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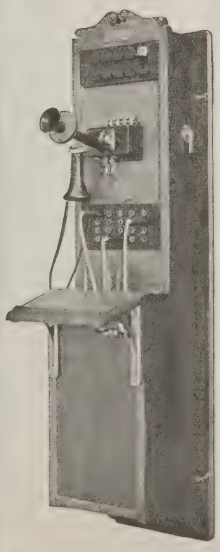
STOCK

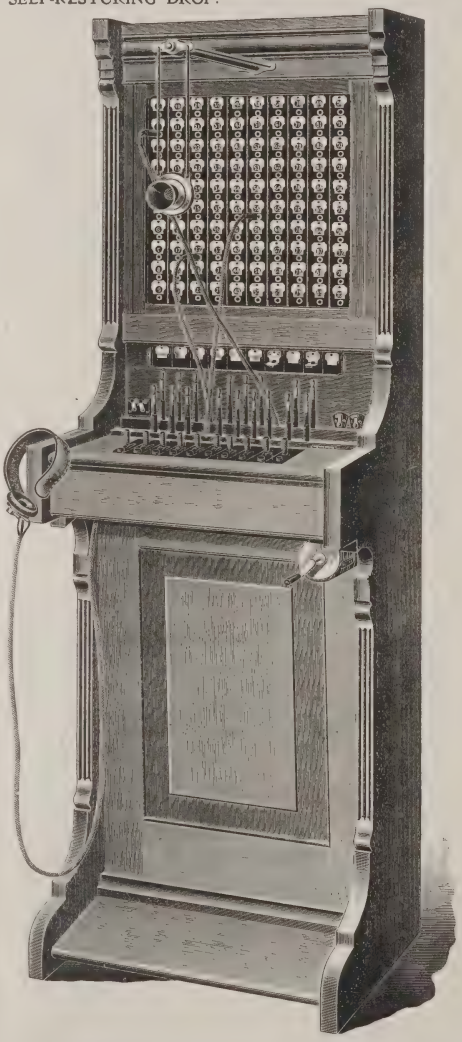


10 DROPS

We never lose interest in the telephone that goes out of our factory. Its daily deportment is our deepest concern. We stand sponsor for it, and our sponsorship does not end when it passes into service.

YOU BUY A GUARANTEE WITH THE INSTRUMENT AND THE GUARANTEE IS GOOD

THE WILLIAMS-ABBOTT STANDARD METALLIC CIRCUIT SWITCHBOARD, EMPLOYING THE H. C. D. SELF-RESTORING DROP.



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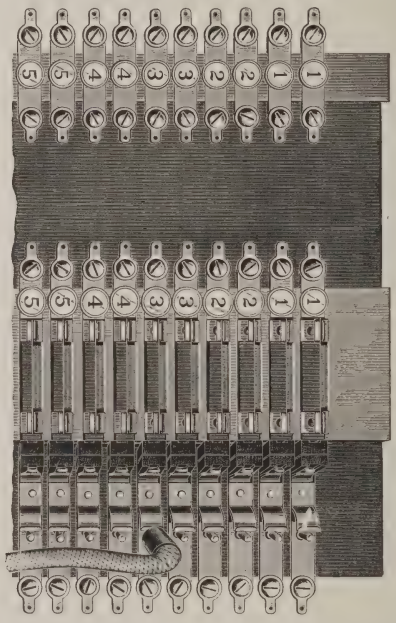
COMPLETE EXCHANGE EQUIPMENT.

The W. A. Standard Metallic Circuit and Combination Local Exchange, Toll and Party Line Switchboards.

Combination Arrester, Distributing and Test Boards.

Cable Pole Lightning Arresters with Testing Clips, Cables, Etc.



COMBINATION ARRESTER, DISTRIBUTING AND TEST BOARD

CORRESPONDENCE SOLICITED.

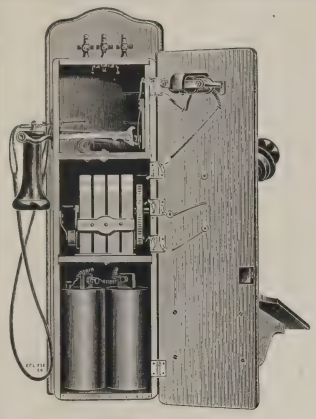
LET US KNOW WHAT YOU WANT.
IT IS ALTOGETHER LIKELY

WE CAN SAVE YOU SOME MONEY.

THE WILLIAMS-ABBOTT ELECTRIC CO.,

CHICAGO SALES OFFICE: MONADNOCK BLOCK. CLEVELAND, OHIO.

Please tell the Advertiser you saw his Announcement in TELEPHONY.



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BY GIVING THESE A TRIAL.

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National Telephone Cable
Ideal Dry Batteries.

Every Telephone Man Should Have Our Price List of Telephone Material.

SEND FOR IT.

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OKONITE IT NEVER DISAPPOINTS

264-266-268-270 FIFTH AVENUE, CHICAGO.

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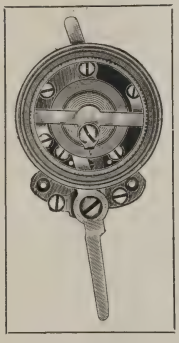
A NEW MODEL.

G.-D. EXTENSION CIRCUIT RINGER.



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Smaller size, stronger mechanically, more positive contact, no possibility of getting out of order, and cheaper in price. Owing to better manufacturing facilities this ringer and the non-automatic closer, are fast replacing all other Extension Circuit devices, either battery or magneto.

The ringer reproduces the signals of a party-line, resetting itself—on a private line it prevents loss of battery power as the extension circuit is opened as soon as the telephone magneto stops ringing.

The closer replaces the ordinary extension drop, having no magnets or coils to burn out, and being much cheaper in cost.

DESCRIBED IN PAMPHLET No. 33.

GARTON-DANIELS CO., - Keokuk, Iowa.

No. 3. Series Telephone
Price, $7.50 each

International Specialty Company

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Every Telephone Guaranteed

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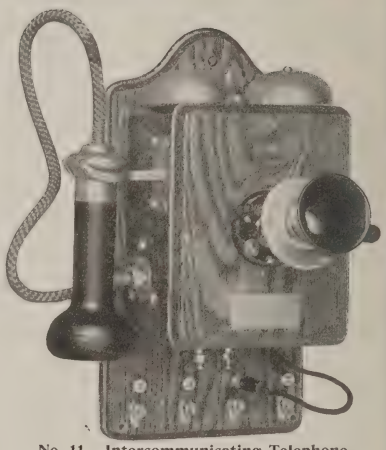
Quality the Highest

Prices the Lowest

A Trial is All We Ask

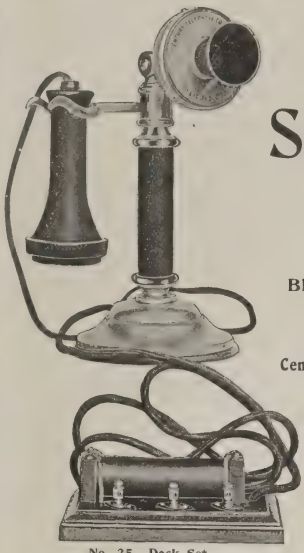


No. 11. Intercommunicating Telephone
Price, with 5 plugs, $6 25
Extra lines, 25 cents each

No. 2. Private Line or Farmer's Telephone
Price, $5.00 each

No. 4. Bridging Telephone
Price, $10.00 each

International Specialty Co., NEW YORK CHICAGO



No. 25. Desk Set.

CENTRAL ENERGY
AND
MAGNETO CALL

SWITCHBOARDS
AND
TELEPHONES.

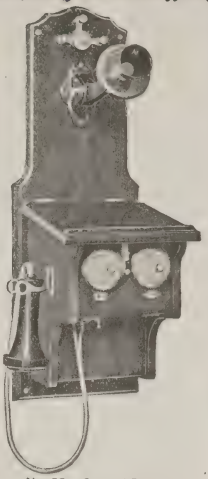
BRIDGING AND SERIES TELEPHONES FOR

EXCHANGES, TOLL LINES,
PARTY LINES, PRIVATE LINES.

Century Transmitters will make your Subscribers Happy.

OUR PRICES ARE RIGHT.

Write us for Catalogue of Switchboards and Telephones.
CENTURY APPARATUS GUARANTEED TO BE PERFECT IN EVERY DETAIL.



No. 55. Central Battery Instrument.

CENTURY TELEPHONE CONSTRUCTION CO.,

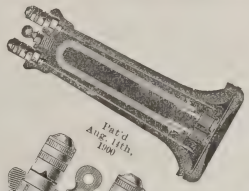
CLEVELAND, OHIO.

General Offices, 200-212 Electric Bldg. Factory, 24 Superior Viaduct.

DROP IT ON THE FLOOR

—you CAN'T break or injure it

IT'S TOUGH!



MR. EXCHANGE MANAGER:

Here's something you need in your system—on your 'phones

A RECEIVER THAT CAN'T GET OUT OF ADJUSTMENT

—that works to-morrow (and forever) as it works to-day.

A SAMPLE

costs one dollar (postpaid); send for one and you'll find

IT'S PRACTICAL—

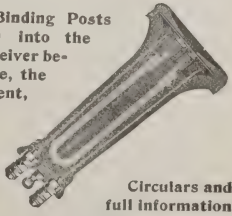
—The BEST Receiver made.

This is THE NEW

SOLID RECEIVER

Magnets, Poles and Binding Posts are solidly MOLDED into the Case; thus does the Receiver become practically one piece, the adjustment is made permanent, and the case becomes

UNBREAKABLE



WE TEST EVERY RECEIVER THOROUGHLY

—We KNOW it's correctly adjusted—and it's GOT to stay so.

Circulars and full information from the manufacturers—

W. J. MURDOCK & CO. CHELSEA, MASS.

If at first you don't succeed
Keep on Trying.
When Good Telephones you need
Keep on Buying.
When to other makes you've pandered
Take a rest;
Then be sure and buy a "STANDARD";
'Tis THE BEST.

THE STANDARD TELEPHONE & ELECTRIC CO.
MADISON, WIS.

OUR PARIS MEDALS

THE HIGHEST

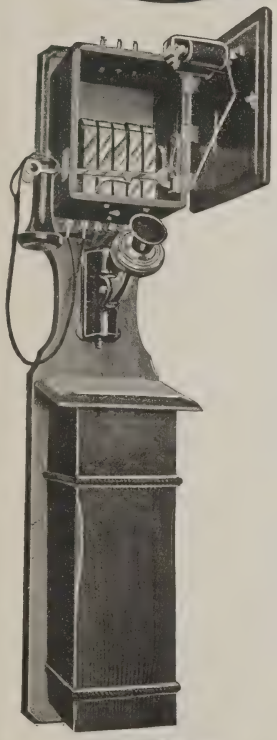
PREMIUM

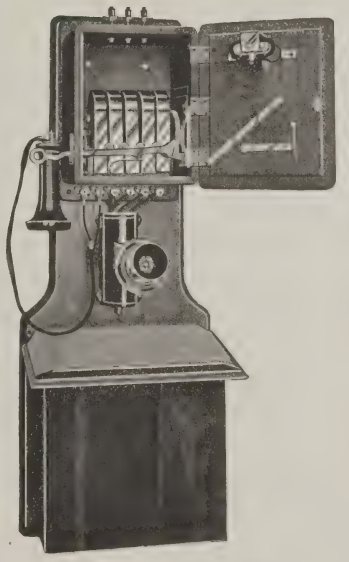
AWARDED TO ANY TELEPHONE MANUFACTURER IN THE

UNITED STATES

OF AMERICA.

50,000 OHM TELEPHONES.





No. 7A. BRIDGING TELEPHONE.
100,000 OHM.

100,000 OHM TELEPHONES.

No. 9. TELEPHONE. Series.
No. 9A. TELEPHONE. Bridging.
50,000 OHM.

OUR 7A AND 9A BRIDGING TELEPHONES ARE THE MOST POWERFUL INSTRUMENTS ON THE MARKET; 20 TO 40 ARE GUARANTEED TO WORK ON ONE LINE SATISFACTORILY.

EXCHANGE TELEPHONES.
A FULL LINE OF
TELEPHONE SUPPLIES.

FARR TELEPHONE & CONST. SUPPLY CO.

123 W. JACKSON BLVD.,
CHICAGO, ILL.

FOR YEARS THE ACKNOWLEDGED STANDARD FOR LONG LIFE AND GREAT STRENGTH.

MADE IN FOUR SIZES

IN STOCK EVERYWHERE

No. 2. "SPECIAL" MADE WITH STICK ZINC FOR TELEPHONE USE.
No. 3. FOR EXTRA HEAVY WORK REQUIRING LARGE CURRENT.

PAMPHLETS AND PRICES FREELY FURNISHED.

ELECTRIC E GAS G BOSTON LIGHTING L MASS. COMPANY C

Please tell the Advertiser you saw his Announcement in TELEPHONY.

OUR
PROTECTORS
PROTECT
AMERICAN
ELECTRIC FUSE COMPANY
NEW YORK
CHICAGO

W. O. MEISSNER, President and General Manager
E. J. WALSH, Secretary and Treasurer.

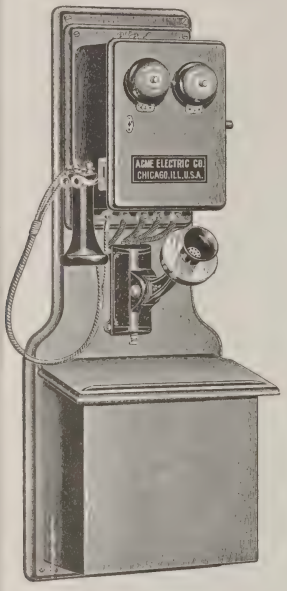
READ THIS AD.—
WRITE TO US.

ACME ELECTRIC COMPANY,

233 South Canal Street, CHICAGO, ILL., U. S. A.

Manufacturers of High-grade Telephone Apparatus.

Special Prices to Manufacturers, Dealers and Large Users.



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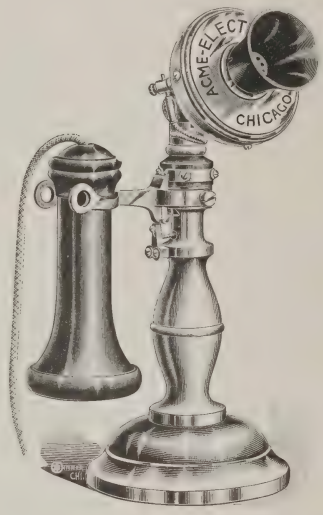


No. 50.

ACME DESK TELEPHONE SET.

No. 36.

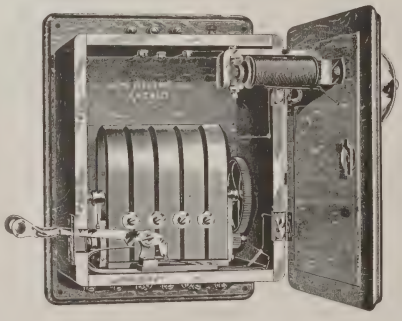
ACME TELEPHONES

Are simply built and strongly built. They are built for service, long service, hard service, constant service, and never fail to give service. They give the best service and continue giving it for the longest time. They save the most time and the most labor and give the least trouble and the least expense.

Is there anything further needed to convince you?

Then read our Guarantee.

It will pay you to write us to-day.



GUARANTEE.

We guarantee efficiency, workmanship and material of Acme apparatus to be of the highest standard.

Acme apparatus is built in our own factory, under the personal supervision of **Mr. W. O. Meissner,** who has spent many years in the manufacture of high-grade apparatus for independent exchanges.

WE WILL SEND CATALOGUE and BEST PRICES

ACME ELECTRIC COMPANY,

233 SOUTH CANAL STREET, CHICAGO, ILL., U. S. A.

BEST APPARATUS. LOW PRICES. PROMPT SHIPMENTS.

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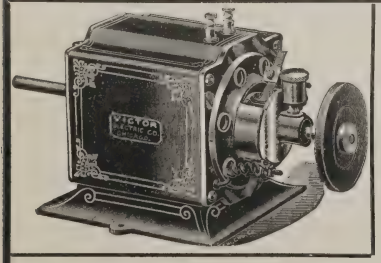
PLEASE MENTION TELEPHONY WHEN WRITING THE ADVERTISER.



VICTOR WINDING MOTOR

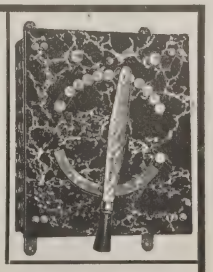
FOR USE ON 110 OR 220 VOLT DIRECT CURRENT.

This is a 1-6 H. P. motor specially adapted for winding small telephone induction coils, magnets, armatures, etc. The use of the fibre hand-brake wheel shown on one end of the armature shaft is so obvious as to require no explanation.

Suitable chucks may be attached to the extended shaft on the end of the machine opposite the brake wheel.

The speed controlling rheostat illustrated, and which is usually furnished with the winding motor, gives eleven speeds.

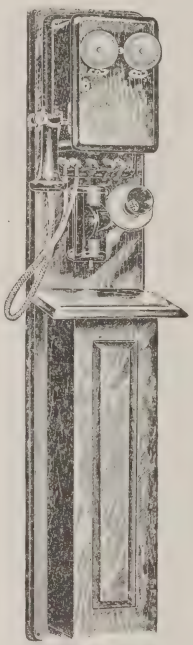
It is so constructed that permanent contact is insured, and the rheostat is practically indestructible.



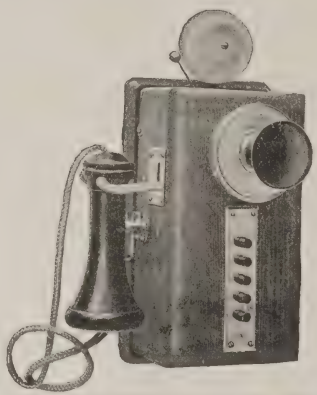
VICTOR ELECTRIC CO., 55, 57, 59 AND 61 MARKET STREET, CHICAGO, ILL.

LATEST DESIGNS OF

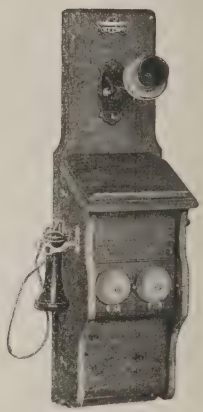
PHOENIX TELEPHONES



PHOENIX TANDEM.



AUTOMATIC INTERCOMMUNICATING BATTERY PHONE FOR INTERIOR WORK.



NO. 20. COMPACT. DRY BATTERY PHONE.

APPARATUS RIGHT.
PRICES RIGHT.
OLD RELIABLE SUTTON MICROPHONES.
LATEST UP-TO-DATE METHODS,
APPARATUS AND PRICES.

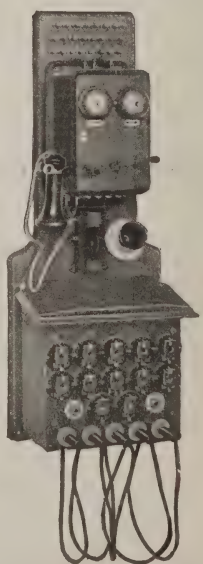
NO. 20. OPEN.

SEND FOR NEW POSTER AND NET PRICES.

PHOENIX ELECTRIC TELEPHONE CO.,

443-445 GREENWICH ST.,

NEW YORK CITY.



SWITCH PHONE FOR TOLL LINES, FARMERS' LINES AND PRIVATE EXCHANGES.

NOW READY!

Telephony's Manufacturers' Mailing List of Telephone Buyers

IN THE UNITED STATES, CANADA, MEXICO AND FOREIGN COUNTRIES.

This List is used by the leading Telephone Manufacturers, Supply Houses, Pole Dealers, etc., and is the only complete list extant.

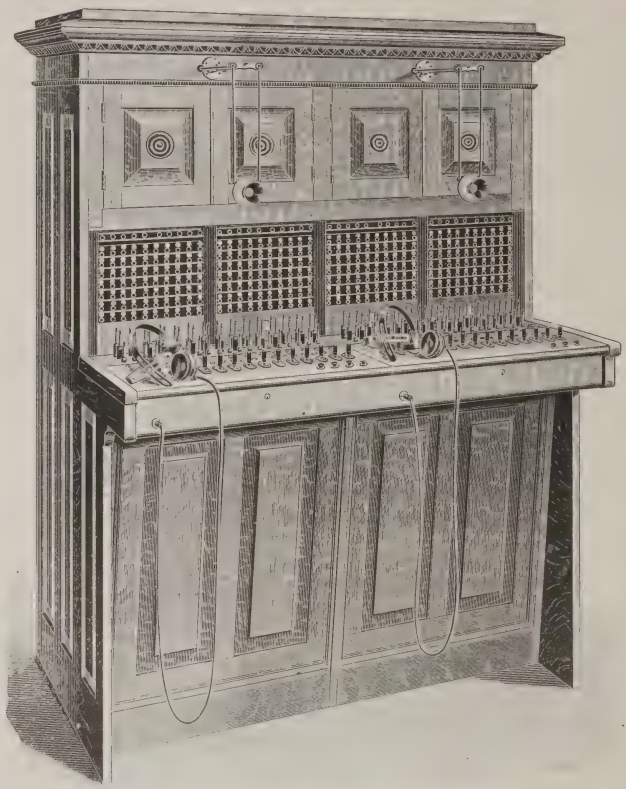
It aggregates nearly 10,000 buyers, Is classified and alphabetically arranged by states and towns in states. It is "THE ONLY ONE."

THE LIST EMBRACES

The Independent Telephone Exchanges, Private Exchanges, Principal Toll Line Companies, Construction Companies, Individual Buyers, Supply Houses, Superintendents of Telegraph, Etc.

ADDRESS

TELEPHONY, MANHATTAN BUILDING, CHICAGO, ILL., U. S. A.



LAMP LINE SIGNAL, CENTRAL ENERGY SWITCHBOARD

The following are a few of the many styles of Transfer Switchboards we manufacture:

LAMP SIGNAL TRANSFER, CENTRAL ENERGY SWITCHBOARD, complete double lamp supervisory, up to 980 lines.

VISUAL SIGNAL TRANSFER, CENTRAL ENERGY, single or double lamp supervisory, up to 840 subscribers' lines.

VISUAL SIGNAL, AUTOMATIC-RESTORING GENERATOR CALL, single or double lamp or signal supervisory, up to 840 lines.

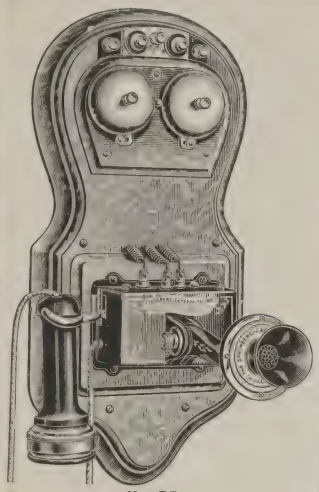
LAMP SIGNAL GENERATOR CALL, single or double lamp supervisory, up to 980 lines.

All Capacities in Lamp or Visual Signal Branch Exchange Switchboards, in either Cabinet or Desk Styles.

GENERATOR CALL, MANUAL RESTORING SWITCHBOARDS, with lamp signal transfer, up to 1,000 capacity.

All Styles and Capacities of Toll Switchboards and Desks. Special Designs for Special Requirements.

The Stromberg-Carlson Telephone Mfg. Co., Chicago.



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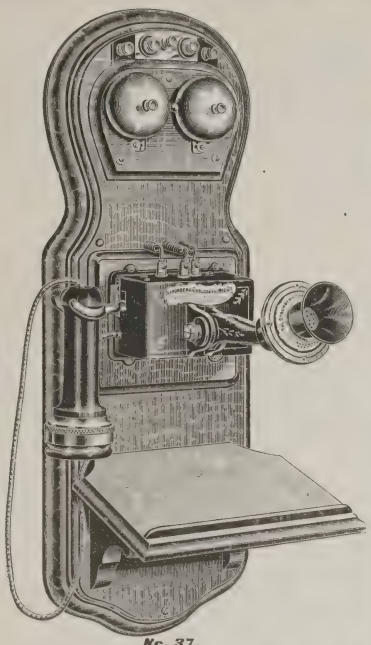

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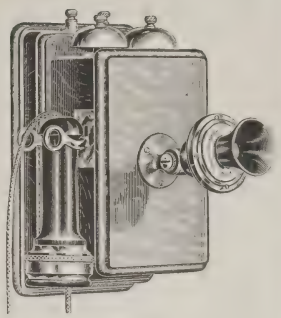

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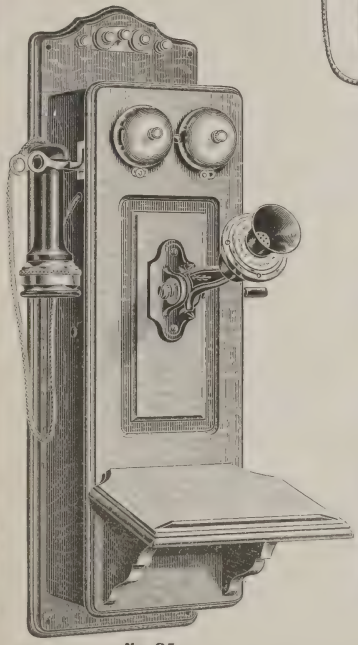

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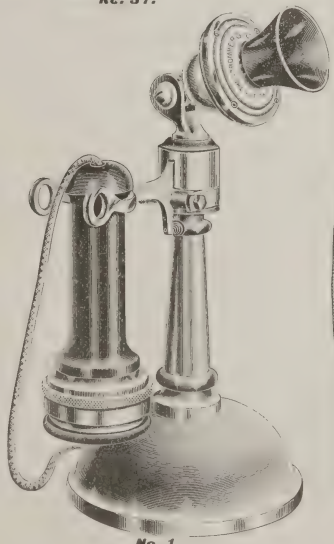

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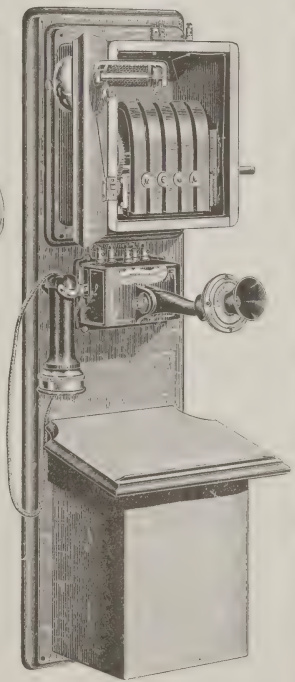
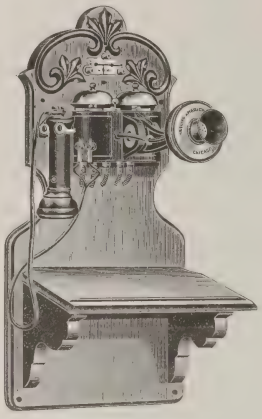


No. 17.

The Stromberg-Carlson Telephone Mfg. Co., Chicago.

CENTRAL ENERGY TELEPHONES

ARE YOU PAYING A FANCY PRICE FOR SAME?

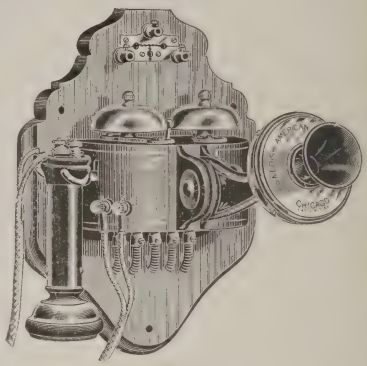


No. 23.

OUR CONDENSERS ARE PERFECT.
ALL CONTACTS ARE PLATINUM.

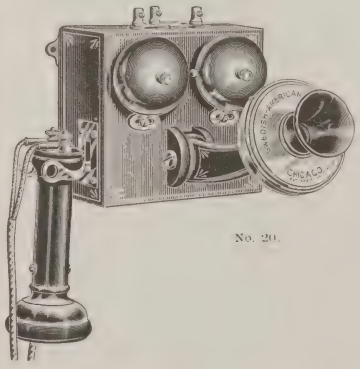
DO YOURSELF A FAVOR BY ASKING FOR FULL PARTICULARS AND **PRICES.**

HANDSOME IN DESIGN. PERFECT IN DETAIL. MINIMUM EXPENSE FOR MAINTENANCE.



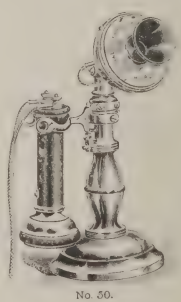
No. 2.

OUR PRICES on Central Energy Telephones are RIGHT.



No. 20.

HIGHEST RESISTANCE TRANSMITTER EVER MADE. VOLUME OF SOUND WAVES UNEQUALLED. IDEAL CONSTRUCTION : : : : : : : : : : STRONGEST RECEIVER ON EARTH BOTH AS TO CONSTRUCTION AND PERFECT RESULTS : : : : : : : : : : : : :



No. 50.

GUARANTEED TO GIVE EMINENT SATISFACTION ON ANY CENTRAL ENERGY SYSTEM.

SEND FOR DIAGRAMS. **WRITE US TODAY.**

SWEDISH-AMERICAN TELEPHONE CO.,

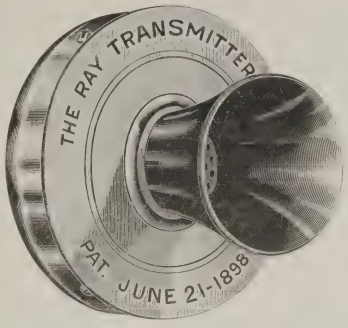
CHICAGO, ILL.

FRANK S. TUCKER & CO.

No. 1 HARTFORD ST., BOSTON, MASS.

MANUFACTURERS OF

TELEPHONE SPECIALTIES, TRANSMITTERS, AUTOMATIC SWITCHES, PUSH BUTTONS, ETC.



THE RAY TRANSMITTER.

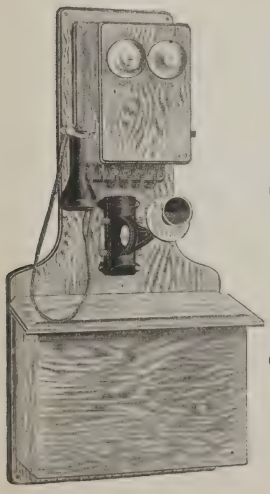
The improvements embodied in the construction and proportions of the cell gives the greatest volume and strength of tone of any transmitter on the market. None of the parts are affected by moisture or sudden changes of temperature and are fully guaranteed.

IN ORDER TO INTRODUCE THESE TRANSMITTERS WE WILL SEND A SAMPLE POSTPAID TO ANY ADDRESS ON RECEIPT OF $1.50.

FRANK S. TUCKER & CO., No. 1 HARTFORD ST., BOSTON, MASS.

WILLIAMS TELEPHONES

Set No. 25.



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OUR VIOLET G. T. & T. C. FOR THE ASKING.
BE SURE AND ASK.

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The Williams Electric Company,

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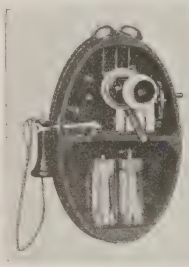

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Without Hinged or
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Remember our Telephone Points,
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THAT HOLD
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Used in any soil.
Roots and stones no obstruction.
Set in five minutes.
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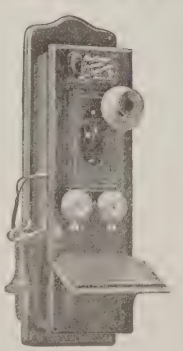

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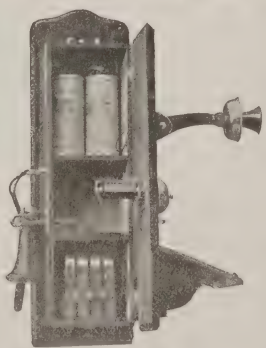

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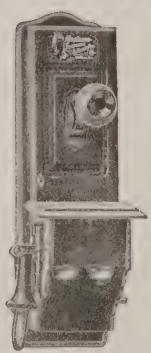

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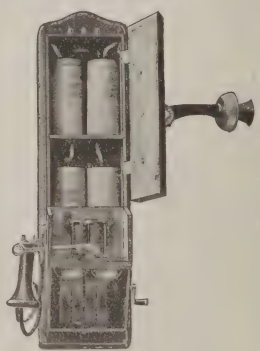

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Look them over, you will find many points of advantage. We have the wet battery kind too. Kokomo has always stood in front. Our prices will interest you.

Write us for NEW Catalogue No. 9, showing our full line.

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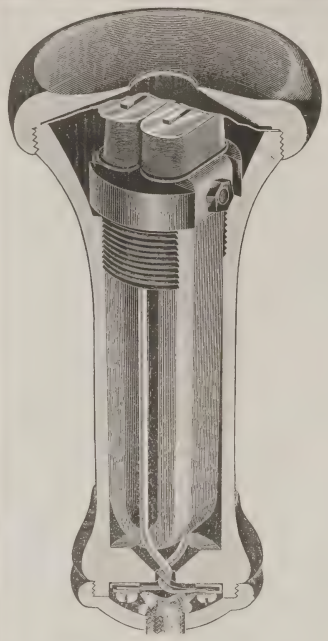

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It has been IMITATED and PIRATED
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New 1902 Keelyn Receiver, single lots, each -	$1.25
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LET THE "PIRATES" IMITATE THESE PRICES.

The new Composite Rubberoid Shell is now offered the first time
NON-BREAKABLE! NON-EXPANDING! SEAMLESS!

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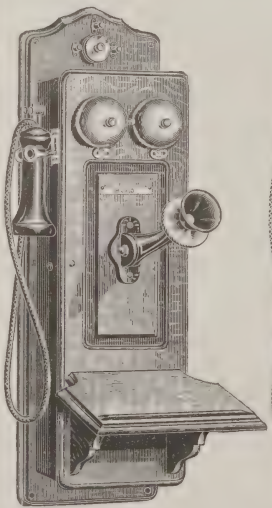
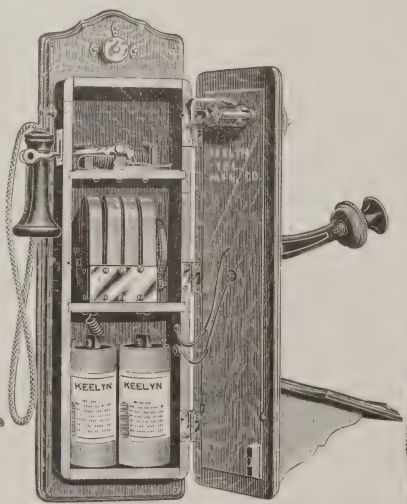
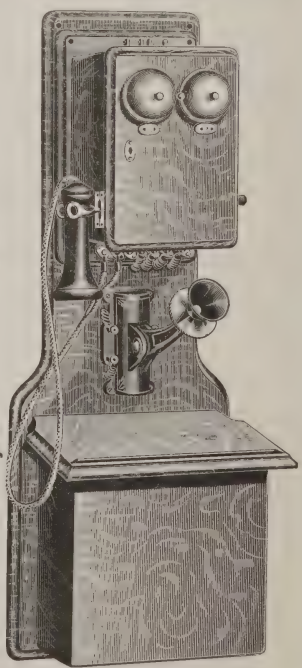


KEELYN 1902 COMPACT.



KEELYN 1902 COMPACT—OPEN VIEW.



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Our Selective Lockout Party Line Telephones

For Use on Isolated Lines and Exchange Service.

Can be applied to any exchange board; 35 telephones can be operated on one line, and the annoyance of calling all subscribers when only one is wanted is done away with. Your conversation is private, as all telephones are locked out when you have your connection.

Write us to-day for information regarding our system.

Did You Know

that if you want telephone service and cannot afford to put a central office exchange in

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that we can furnish you with an automatic exchange which will cost you practically nothing to operate and not very much to install, and which does away with the central office entirely. This is the ideal system for any city desiring telephone service which

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IMPORTANT NOTICE.

We have purchased the patents of the Drake Telephone Co. covering the Drake Selector and Battery Cut-out, and have made various improvements on the system on which patents are pending.

Representatives Wanted. Men Understanding The Telephone Business Only.

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High Grade Telephones

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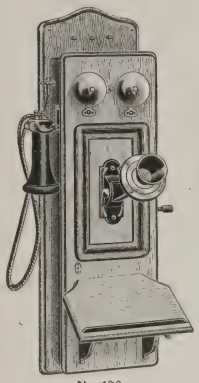

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1,000 Ohm bridging	9 25
1,600 Ohm bridging	9 50

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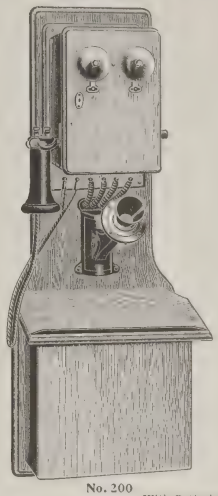

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1,000 Ohm bridging	9 75
1,600 Ohm bridging	10 00

NEW CREATIONS BORN FROM EXPERIENCE, NOT MODIFIED EXPERIMENTS.

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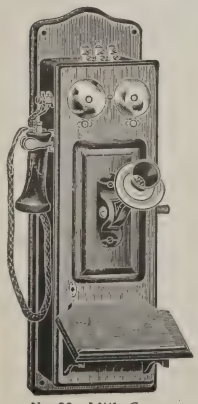

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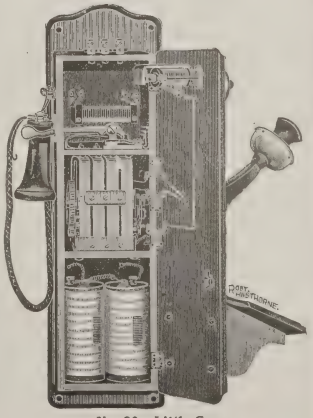
THEIR ENTIRE CONCEPTION IS DICTATED BY THE DEMANDS OF USAGE.

THEIR APPEARANCE AS COMPLETE AS A WATCH.

ORDER A SAMPLE; IT WILL TELL THE WHOLE STORY.



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One Position Toll Desk—10 Lines.

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COMPLETE EXCHANGE
COMMON
COMBINED DISTRIBUT
PROTECTORS,
OFFICE AND POLE
TELEPHONES, FUSES
TEST CONNECTORS,

COMMON BATTERY WALL SET.

Adjustable Arm.

Transmitter always Horizontal.

Bi-Polar permanently adjusted Receiver.

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Natural Oak,

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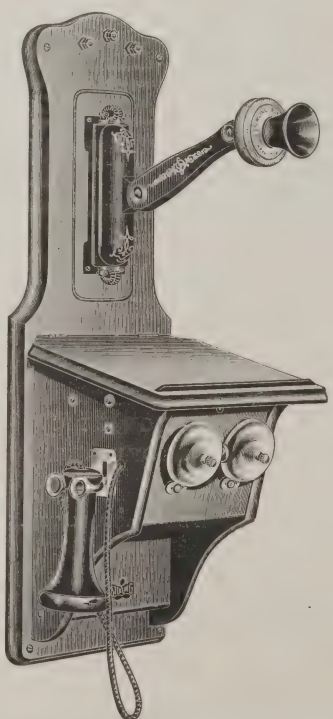

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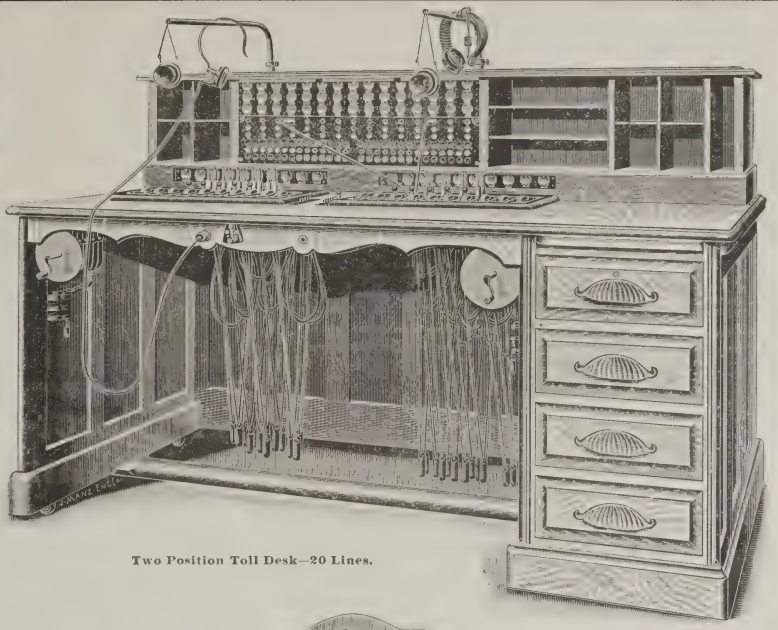

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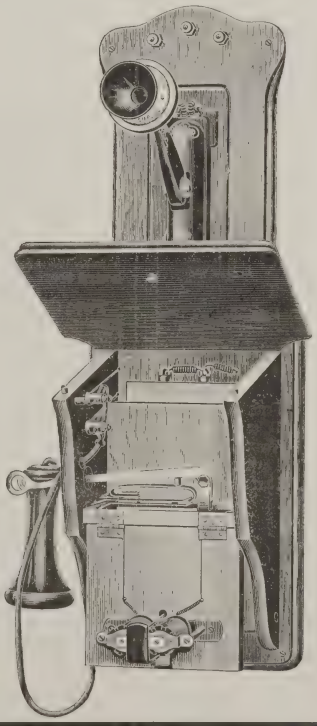

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Bell Box Open.

Condenser in Back.

Long Lever Switchhook.

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Centrally Pivoted Armature.

Loud, Clear-Toned Gongs.

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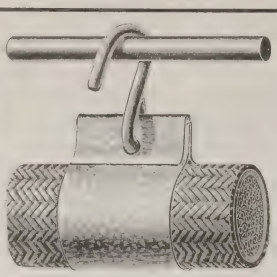

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for the
WRIGHT
and get the
RIGHT
which is the
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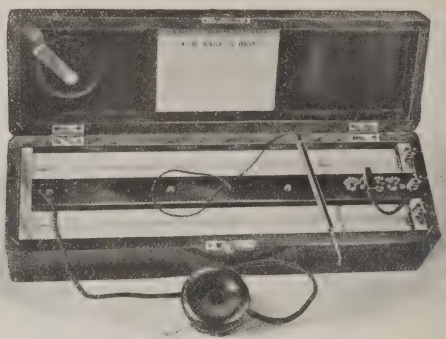

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that has stood the test of 3 years. It has 4 scales, aggregating 120 inches of slide wire.

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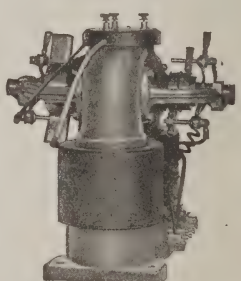
Twin Motor-Generators and Belted Generators for charging batteries.

Ringing Generators for ringing telephone bells.

Special attention given to Machines for Telephone Switchboard work.

Twin Charging Motor-Generators and Ringing Generators built to run on any direct current of 110, 220 or 500 volts.



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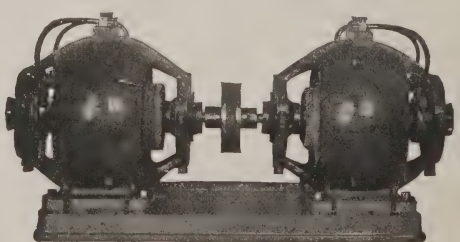
Special attention given to 500-Volt Primaries, for operation on Street Railway circuits, Alternating Current Motors direct connected to Charging Generators Ringing Generators wound to run on battery circuits



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ROTH BROS. & CO., Manufacturers,
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Telephony.

AN ILLUSTRATED MONTHLY TELEPHONE JOURNAL

VOL. II. CHICAGO, DECEMBER, 1901. No. 6.

NOTES ON THE EVOLUTION OF ELECTRICAL TRANSMISSION OF SPEECH.

BY FRED DE LAND.

Some day ample proof may be forthcoming that the art of telephony, or of the transmission of articulate speech over distances, instead of being a nineteenth century invention, really had its beginning in the dawn of an ancient civilization. And how very long ago that may prove to be, who can tell? Excavations in "the alluvial deposit which now forms the arable soil of Egypt"[1] indicate the existence more than six thousand years ago of a civilization so advanced in character that during its attainment even a greater period of time than sixty centuries may have passed away. While the recent "remarkable discoveries on the site of ancient Nippur show that ten thousand years ago there existed a civilization as comprehensive as our own—a commercial system built on 'modern lines.'"[2] And at a depth of more than a hundred feet in the gold-bearing gravel of the Pacific slope, bones of human beings, vegetable remains and traces of man's presence have been found, overlaid with four successive lava-streams from long-extinct volcanoes.[3] Facing these discoveries of prehistoric art treasures, who dare deny the possibility of some enthusiastic explorer uncovering in bosom of Mother Earth a telephone exchange with the equipment utilized in those prehistoric days by "the primitive people of Africa, who constituted the entire population of neolithic times,"[4] or when she was nursing a race of civilized beings who lived and loved and voyaged across the sea eternal ten thousand years before existing human races came to people the earth?[5]

But admitting that prehistoric man was our equal in every respect; that no matter how far back we go in the history of the earliest recorded civilization we ever find comprehensive functions centuries old; that "a Mediterranean race already existed 12,000 years ago;"[6] that in the year 4004 B. C. Cushite cities were decaying; "that about 4004 B. C. . . . we find the Euphrates valley divided into a series of states or principalities (grouped) around certain cities;"[7] yet the fact remains that no authentic record has ever been found showing that practical methods, either electrical or otherwise, for the transmission of speech over long-distance were known to the ancients, or that the problem of telephonic transmission of complete sentences under practical commercial conditions was solved prior to the last quarter of the nineteenth century. Had such practical method of speech transmission ever existed there is little doubt that the world would have learned of it ere now. For, as Reed says, "though nations die and dynasties perish, the world absorbs all the knowledge and culture once got and holds it forever. . . . It is a favorite theme with some—the lost achievements of the past—and yet, if there be any useful invention lost, it is because a better has taken its place. There are no lost arts. Oratory has created all that there seem to be."[7] But Benjamin claims that "there can be little doubt but that many of the inventions made by the acute student minds which congregated in Egypt were totally forgotten and lost during the dark ages."[8]

It is well known that certain passages in the Bible have been offered as proof that both the telegraph and the telephone were utilized by the inhabitants of ancient cities. One ardent student devoted a pamphlet of sixteen pages to an interesting presentation of his reasons for believing that telephone service is predicted in "The Revelation of St. John the Divine."[9] Then Jehovah's question to Job: "Cans't thou send forth lightnings that they may go and say unto thee, Here we are?"[10] is presented by some writers as relating to the utilization of the electric current for the transmission of intelligence, and not to atmospheric disturbances, as the context appears to indicate. And a similar use has been made of David's declaration of the glory of the firmament: "Their line is gone out through all the earth and their word to the end of the world."[11] But there are no authentic records to substantiate these deductions, even though we admit that Job was "familiar with the whole range of the larger world" and had "marked the lessons of nations in their rise and fall,"[12] and that his writings may be the most ancient of all biblical literature. Then that nameless Homer of the Hebrews, who portrays in unfading colors the achievements of Joseph and Moses, utilizes the crude cloud of smoke for the conveyance of signals. David, too, glories in picturing life in the cities, but fails to record so important a function as the transmission of conversation. Had there been a telephone exchange in that chief city of "God's chosen people," how sublime and poetically musical would have been David's description of the transmission of the tones of the human voice over long distances, and how the tones of his friends would appear as more entrancing than the sweetest chords of his favorite instrument, as he portrayed them in word-colors richer than ever painter's palette bore. Nebuchadnezzar has told how he labored to build up Babylon, and how in the temple of his gods "everything that is prized, is magnificent, substance, wealth, the ornaments of majesty, I heaped up within it; strength, splendor, royal treasure, I hoarded within it."[12½] But in all the details there is no word of a method of communicating from palace to temple.

That the art of conveying intelligence by visual or semaphoric signals was well known in the dawn of civilization is a matter of record, fire signals and beacon stations being used at night and smoke signals by day, not only by

1. "The Dawn of Civilization: Egypt and Chaldea." G. Maspero. London, 1896.
2. "Ancient Nippur." Theodore Waters. Current Literature, New York, April, 1901.
3. "Atlantic Monthly." Boston, April, 1891. Nation, New York, May 21, 1891.
3½. "The Mediterranean Race: A Study of the Origin of European Peoples." G. Sergi. London, 1901.
4. "The Psychological Unity of Mankind." C. S. Wake. Memoirs read before the Anthropological Society. Vol. III. London, 1870.
5. "The Doctrine of Descent and Darwinism." Oscar Schmidt. New York, 1892.
6. "The Religion of Babylonia and Assyria." Morris Jastrow, Jr. Boston, 1898.
7. "The World's Wish for Peace." Thomas B. Reed. Saturday Evening Post, Philadelphia, January 13, 1900.
8. "The Intellectual Rise in Electricity." Park Benjamin. New York, 1895.
9. "Invention of the Telephone Predicted in the Book of Revelations." W. Coldbrook. London, 1891.
10. "The Holy Bible: The Book of Job." xxxviii:35.
11. "The Holy Bible: The Book of Psalms." xix:4.
12. "The Modern Reader's Bible." R. G. Moulton. New York, 1895.
12½. "The India House Inscription of Nebuchadrezzar the Great." Rev. C. J. Ball. Records of the Past. Edited by A. H. Sayce. New Series. Vol. III. London, 1891.

early man, but even into the nineteenth century. When Troy fell, "light answering light, they sent the tidings on," and the fate of the French at Waterloo was signaled "along the Falmouth and Dover roads to London by swinging arms mounted on the tops of masts."

But even the marvelous descriptive powers of eminent Arabian and Persian writers and of all poetic license seemed to fail in conceiving of two human beings, separated by leagues, carrying on an interesting conversation with the aid of a wire and some simple mechanism.

The claim has been made by believers in theosophy that the early Egyptians possessed the knowledge of "a force more potent, subtle and extraordinary than electricity," by means of which they were enabled to send invisible communications over long distances. Whether the Eygptians were familiar with the phenomena of thought-transference and were able to obtain an instantaneous mental telegraphic effect through a cultivated power of close concentration in the operator and complete receptive passivity in the reader remains to be demonstrated. But there is little on record to satisfactorily substantiate this claim. Madame Blavatsky states that Randolph claims to have "found good evidence during his stay in Egypt that one of the Cleopatras sent news *by a wire* to all the cities from Heliopolis to Elephantine, on the Upper Nile."[12] She further states that "the day that England, and, in fact, all humanity, lost General Gordon at Khartoum, several of the people in the streets and bazars of Cairo knew of his death. The question arises, How did they get hold of the information? There is no railway or telegraph system from one city to the other; the distance in a direct line from Khartoum to Cairo cannot be less than a thousand miles. It would seem that the Oriental methods of signaling without wires must rest entirely on a highly-trained mental effort." But Cardinal Richelieu also claimed "that he knew what passed in remote places as soon as it happened, and it is affirmed that with such an instrument he gives and receives immediate advices."[13] However, Cleopatra's scientists may have anticipated Oliver Lodge in the belief that they were living in an infinite, all-permeating ocean of ether as fish live in the sea, and they may have found in the human brain "an organ capable of transmitting and receiving other electrical rays of wave-lengths hitherto undetected by instrumental means."[14]

Now the fundamental principles underlying modern telephony, or the electric transmission of speech, are the simple and well-known laws governing the science of electricity and magnetism. Yet a careful search through all existing records reveals that the knowledge possessed by our ancestors concerning the nature of what we now call electricity and magnetism was so slight that until the seventeenth century of the Christian era it was comprised solely in certain views more or less erroneous regarding the attractive virtues of the lodestone and of amber. Concerning galvanic, voltaic and dynamic electricity and electro-magnetism, there is nothing on record prior to about the close of the eighteenth century. Not until the opening of the seventeenth century was a systematic study of magnetism undertaken. To Dr. William Gilbert belongs the credit of making this research. While so engaged "he frequently translates the English word amber into the Latin electrum" and thus coins the new word "electrica translatable as electrics, which he defines as signifying those substances which attract in the same manner as the amber."[15] (The ancient Greeks called amber "electron," as they did many other substances giving a yellow glow.) And not until the year A. D. 1639 was the magnetic quality of the lodestone properly defined as "magnetism," and the "magnetism of electrics or the attraction of electrics and their causes" defined as "electro-magnetism."[16] The credit for coining or recording these definitions is given to Athanasius Kircher, a Jesuit professor residing in Rome, whose small treatise on the magnet was published in the year A. D. 1641. The word "electricity" is not found of record prior to the year 1621. Its invention or coinage is credited to Jean Baptista Van Helmont, a Flemish physician and chemist, who published at Paris a treatise on the magnetic cure of wounds, and the word was first found in Charleton's translation of Van Helmont's works.[18] Park Benjamin believes "that was the first appearance of the actual word which is now the name of the science."[19] But Benjamin has also called attention to the use of the word "electrics" by Sir Thomas Browne, in 1646.[20] The first book in the English language devoted entirely to the subject of electricity is Boyle's little treatise,[17] which appeared in the year 1675, and refers only to the attractive qualities of the lodestone and of amber. Sixty-seven years later, in 1742, Desaguliers published what is said to be the second book on the subject of electricity in the English language,[18] "a disquisition for which he was awarded the prize of the Academy of Bordeaux for the best essay on electricity," and a French translation of which was published the same year at Bordeaux.

We may never learn who first observed and recorded the fact that the yellow, resinous substance we call amber, when rubbed on a soft surface, attracts and holds bits of paper, lint and feathers, or that the lode—or leading, or Heraclean—stone attracts and holds iron to its surface. But the bits of amber found in the relic beds of the earlier lake settlements, and the amber beads found in the royal tombs of the earliest of Egyptian monarchs, presupposes a knowledge of its attractive virtues ages ago. Yet, strange as it may appear, the first authentic reference of a satisfactory nature is found in the writings of Plato (429 B. C.-348 B. C.), who lived at a period some two hundred years after Thales (600 B. C.), to whom is generally credited the earliest knowledge of the attractive properties of amber and the lodestone. If Thales was familiar with the virtues of amber, his most kindly biographer[19] forgot to mention it. And Benjamin has shown on how doubtful a foundation rests the claim that to Thales belongs the "first conception of a soul in the amber."[20]

Plato records that Socrates, in describing the power of certain men to inspire and influence other men, said to Ion: "There is a divinity moving you, like that in the stone which Euripides calls a magnet, but which is commonly known as a stone of Heraclea. This stone not only attracts iron rings, but also imparts to them a similar power of attracting other rings, and sometimes you may see a number of pieces of iron and rings suspended from one another so as to form quite a long chain, and all of these derive their power of suspension from the original stone."[20]

Three centuries later a similar chain of "Samothracian iron rings" was described by the Roman poet-philosopher, Lucretius,[21] who, "so far as the knowledge of his time would allow him to be, was as completely and as consciously a scientific man and a physicist as Darwin or Huxley, or any of our contemporary evolutionists,"[22] yet who passed away "fifty years before Christ was born." Lucretius first recorded the repelling power of the magnet, as well as other important observations regarding magnetic effects, as follows:

> "Oft from the magnet, too, the steel recedes,
> Repelled by turns, and reattracted close;
> And oft in brazen vessels may we mark
> Ringlets of Samothrace, or fragments fine,
> Struck from the valid iron, bounding high
> When close below the magnet points its powers."[23]

12. "Isis Unveiled." Mme. H. P. Blavatsky. New York, 1866, and "Pre-Adamite Man." P. B. Randolph.
13. "Letters Writ by a Turkish Spy." Thirteenth Letter, dated Paris, 1639.
14. "Some Possibilities of Electricity." William Crookes. The Fortnightly Review, February, 1892.
16. "A Ternary of Paradoxes of the Magnetic Cure of Wounds, etc." Walter Charleton, Second Edition. London, 1650.
17. "Experiments and Notes About the Mechanical Origin or Production of Electricity." Robert Boyle. London, 1665.
18. "Dissertations on Electricity." J. T. Desaguliers. London, 1742.
19. "Biographica Philosophica." Benjamin Martin. London, 1764.
20. "The Dialogues of Plato." (The Ion, p. 533. The Timaeus, p. 80) Jowett's Translation. London, 1892.
21. "T. Lucreti Cari De Rerum Natura Libri Sex." (vl:1050) Munroe's Translation. Cambridge, 1891.
22. "Lucretius on Life and Death." W. H. Mallock. New York, 1900.
23. "Lucretius on the Nature of Things." (vl:1073) Watson's Translation. London, 1898.

Then, five hundred years later, or eight centuries after Socrates drew his interesting eulogy with the hollow amulet rings, Saint Augustine, "the last of the fathers educated in philosophy,"[24] gives an interesting description of a similar chain of rings: "I was thunderstruck when I first saw an iron ring attracted and suspended by the magnet stone, and then, as if it had communicated its own property to the iron it attracted, and had made its substance like itself, this ring was put near another and lifted it up, and so as the first ring clung to the magnet, so did the second ring to the first. A third and a fourth were similarly added, so that there hung from the stone a kind of chain of rings, with their loops connected, not interlinking, but attached together by their outer surface. Who would not be amazed at this virtue of the stone, subsisting, as it does, not only in itself, but transmitted through so many suspended rings and binding them together by invisible links."[25]

While "there are Jewish writers who assert that the Hebrews were well aware of the magnet and its attractive force," Benjamin deems their claims vague and doubtful. He also points out[26] "the lack of evidence tending to show that the Egyptians of the Pharaonic period had knowledge of the lodestone." Yet Barber believes that the Egyptians "were eminently a scientific and mechanical people."[27] Whether the passage, "its water is fire, its stream a flame; it is fire, flame and incandescence," in the "Book of the Dead," refers to an electrical display is yet to be determined. Budge mentions[28] a queen, "wise, prudent and skilled in magic," who, after the army of Pharaoh was drowned in the Red Sea, studied "the secrets of nature" and "all the attracting or repelling powers which were contained in minerals." If this legend is true the Pharaonic priests may have taught that the lodestone was supernaturally influenced, as did the priests of the Cabiric mysteries in Samothrace, "who sold magnet rings to cure rheumatism and gout."[29] And it may yet be possible to trace to this ancient belief the reason why Moses commanded, when building the altars of stones, "that thou shalt lift up no iron tool upon it[27] . . . for if thou lift up thy tool upon it, thou hast polluted it"[28] (B. C. 1491). For far back of the time of Moses the Egyptians believed that "no one could make use of certain qualities of iron without incurring a taint prejudicial to the soul both in this world and the next." Commenting on these old superstitions, Huxley has shown how "the Christians of the twelfth century, after our era, were sunk in more debased and brutal superstitions than are recorded of the Israelites in the twelfth century before it."[29] And this superstitious fear of the power of the unknown may account for the dread of pollution prevalent among sailors in the thirteenth century, when Brunetto Latine, "the celebrated Florentine grammarian and preceptor of Dante," in describing the compass, wrote that sailors dislike "to use an instrument which carries so great an appearance of being constructed under the influence of some infernal spirit."

Benjamin states that "no reference to the lodestone appears in Chinese literature until 121 A. D. . . . No recorded evidence of the attraction of the magnet or amber appears in the Chinese books of earlier date than the fourth century of our era, and then we find it explained by a physical theory totally out of harmony with Chinese modes of thought and the same as that which had been advanced by the Greeks eight hundred years before."[30]

During the period of nearly seven hundred years following Saint Augustine's description, many observations regarding the magnet and amber may have been recorded, but none of value have been found. Students have searched in vain through all existing records covering the history of all that relates to the advancement of civilization from the time of Plato (400 B. C.) to the beginning of the thirteenth century of the Christian era, for proof that the nature of the magnetic attraction that held those suspended rings was comprehended and utilized for the benefit of mankind. Yet in that simple display of the "magical effect of magnetism" lay *the germ of the telephone.* The Greeks, and the Romans, too, had all the elements that combine to make possible the electric transmission of speech as the spoken word was transmitted at the Centennial in A. D. 1876, but they comprehended not the value that would accrue to every community from a successful combination of these simple elements. Park Benjamin has written that "among the wonders of that strangest manifestation of the energy which pervades all nature, and which we call electricity, there is nothing more remarkable and more impressive than the growth of the single, simple and uncoordinated fact—namely, that amber, when rubbed, behaves in a curious way—into the great science which underlies the telegraph, the electric light and the telephone."[30] And he might well have added, nothing is more impressive than the realization that with all of the knowledge and with all the philosophy of twenty centuries the generally accepted belief among the more intelligent was that amber derived its attractive power from the workings of a soul imprisoned within the substance. Even the Greeks "speculated upon an amber life and an amber soul as its essence," because when "rubbed it seemed to live and to exercise an attraction upon other things distant from it;"[30] and it was the Greeks who gave to amber the name electron, because its golden glow recalled the glorious sunshine—"they were all children of the Sun 'Elector,' reflecting in miniature his radiance."[31]

Mr. Reed has shown how these ancient beliefs combined to hinder progress, and to what an astonishing degree the "element of time has entered into the production of our commonest home comforts. . . . Every new thought and almost every new discovery which is born into the world is born into a world which, at the worst, fights it on sight, and, at the best, is utterly indifferent to it. Its first struggle is to get any attention whatever. It finds mankind adjusted to its old ways and taking notice of nothing else."[31] For "the ordinary run of men live among phenomena of which they know nothing and care less. They see bodies fall to the earth, they hear sounds, they kindle fires, they see the heavens roll above them, but of the causes and inner working of the whole they are ignorant, and with their ignorance they are content."[32] "Even up to the beginning of the nineteenth century, so strong a hold had superstition on the human mind, that inventions were almost synonymous with the black arts, and the struggling genius had not only to contend with the natural laws and the thousand-and-one expected difficulties that hedge the path of the inventor, but had, also, to overcome the far greater obstacles of ignorant fear and bigoted prejudice."[33]

The early history of the mariner's compass and of the electric (or magnetic) transmission of intelligence are closely interwoven, and it is broadly claimed that "the science of magnetism made no real progress until the invention of the mariner's compass." And yet it is very doubtful if the world will ever learn the name of the individual who invented the first crude magnetic device from which was developed the modern mariner's compass, which, like the telegraph and the telephone, materially aided in making all the world neighbors. In fact, the world may never be able to accurately decide what nation first utilized and improved this instrument for use on sea and shore. But Dr. Wallis believes that "he who first observed that the magnet has a polarity, or indication northward, made the first step to-

24. "The City of God." Aurelius Augustine, Bishop of Hippo. (21:4) Dod's Translation. Edinburgh, 1871.
25. "The Mechanical Triumphs of the Ancient Egyptians." F. M. Barber. London, 1900.
26. "Egyptian Magic." F. W. Budge. London, 1899.
27. "The Holy Bible: Deuteronomy." xxvii:5.
28. "The Holy Bible: Exodus." xx:25.
29. "Science and Hebrew Tradition: The Evolution of Theology." T. H. Huxley, New York, 1894.
30. "The Age of Electricity: From Amber-Soul to Telephone." Park Benjamin. New York, 1892.
31. "The Rule of Public Opinion." Thomas B. Reed. Saturday Evening Post, Philadelphia, November 18, 1899.
32. "Pioneers of Science." Oliver Lodge. London, 1893.
33. "The Progress of Invention in the Nineteenth Century." E. W. Byrn. New York, 1900.

ward this invention."[33½] And even "the whole subject of terrestial magnetism is still enveloped in mystery."[34] Park Benjamin "examined in vain the knowledge of all nations which at various times and by various authorities have been credited with its invention," and then presents the evidence that led him to decide that "the first of all known descriptions of the mariner's compass" is found in the writings of Alexander Neckam, an English monk, who was born at St. Albans, England, in September, A. D. 1157, and died at Kempsey in 1217. The first authentic description of the Chinese marine compass is found in a treatise known to have been written in A. D. 1297, though at "the end of the eleventh century" it was written that "the Soothsayers rub a needle with the magnet stone, so that it may mark the south; however, it declines constantly a little to the east. . . . Our Soothsayers have some which show south and some which show north. Of this property of the magnet to indicate the south, no one can tell the origin." Judging by the identity of the two instruments, European and Chinese, Benjamin believes that "few will fail to reach a reasonable conviction that the mariner's compass of the East is literally a 'Chinese copy' of the instrument which led, not the indolent Asiatic, but the daring mariners of England and Spain and Portugal and Italy to the most magnificent achievements of the human race."[35] In 1242, one Bailak, a native of Kibdjak, wrote a treatise on stones, in which is found "the first of all Arabian descriptions of the compass. . . . The earliest Spanish record of the compass which has been found is in a compilation of laws made in 1263."[36] That nations other than the English were familiar with some form of compass as early as the thirteenth century is indicated in the following extract from a work on oriental history, written by Cardinal de Vitry, about the year 1215: "The iron needle, after contact with the lodestone, constantly turns to the North Star . . . and hence it is essentially necessary to those navigating on the ocean."

About the year 1190 Neckam wrote a treatise on natural science entitled De Natura Rerum.[36] It was written in prose, exists in the form of four manuscripts, and presents a highly interesting picture of the notions about natural science then held by men of learning, together with many quaint stories and illustrations, "a treasure-house of curious folk-lore and legends." Later, in the form of a single manuscript, he presented in elegiac verse a paraphrase of this prose work, adding some fresh matter and leaving the stories out. He also wrote a kind of vocabulary in the form of a reading book, entitled De Utensilibus,[36] of which there were several manuscript copies.[37] Neckam's writings show how very slight was the knowledge then recorded concerning magnetism, and how crude and imperfect were the few methods adopted for its utilization; for he "linked together all the electric knowledge of his time . . . discusses amber and lodestone attraction, the repelling effect of the magnet, the polarity of it, and as the fruit and flower of all exhibits the mariner's compass."[38] In his treatise De Utensilibus, Neckam "enumerates, among the ship's stores, a needle which was placed on a pivot and when turned round and left to take its own position in repose, taught the sailors their way when the polar star was concealed from them by clouds or tempests."[38] And it is this paragraph that forms "the earliest definite mention as yet known of the use of the mariner's compass in the middle ages."[39]

Nowhere in Neckam's manuscripts is there any indication of the compass, or the "sailing-stone," he describes being a recent invention; on the contrary, he appears to be describing an instrument in common use and one familiar to mariners. Hence, it is reasonable to suppose that a magnetic device similar to the compass may have been and probably was in use for many centuries before Neckam's time. In view of all that has been written about the earliest voyages by sea, it seems very strange that if the lodestone was not an object of common utility, some one did not record how the mariners planned their course on stormy nights. It is known that Phoenician sailors "worked both tin and copper mines in Cornwall, and made profits in the sale of the products throughout the known world. They passed up the British Channel and through the German Ocean, and in the immense sand dunes at the mouth of the Baltic discovered and utilized that beautiful product of the primeval forests called amber, which they dug from the sand hills."[40] Yet there is nothing on record to show that these primitive ships carried any form of directive instrument to aid the mariner in navigating strange seas and reaching his destined port.

That the ancient English word "compass" is often found in early writings, is admitted. But the context usually shows that the reference is to a circle or circuit which was the original meaning. For instance, in the King James' version of the New Testament, St. Paul's words are recorded:[41] "And landing at Syracuse, we tarried there three days. And from thence we fetched a compass, and came to Rhegium." While the revised version of 1885 reads: "And touching at Syracuse, we tarried there three days. And from thence we made a circuit, and arrived at Rhegium." Again the word "compass" is used in early writings in defining dividers or drawing instruments. In this sense it is used in several translations of the Rubaiyat of Omar Khayyam, "the astronomer-poet of Persia and the greatest scholar of his time," who died in the year A. D. 1123.

Eighty years after Neckham's description of the mariner's compass appeared, a knight, resting in the trenches in front of the besieged town of Lucera, in Southern Italy, wrote to his neighbor, Sigerus, a letter dated the twelfth day of August, A. D. 1269, in which he enumerated certain experiments and discoveries in the field of magnetism. This knight was the celebrated mathematician, Peter de Maricourt, better known as Peregrinus, or Pilgrim, by reason of a pilgrimage to the Holy Land, and was the "Picard from Maricourt" on whom Roger Bacon "lavished all his praise, all his enthusiasm." While engaged in military engineering and other field duties, "Peregrinus," says Benjamin, "seems to have conceived the idea of converting the sphere of Archimedes into a self-moving magnetic motor, and then to have gone a step farther and evolved a magnetic perpetual motion on an entirely different principle. In reaching these delusions Peregrinus discovered and differentiated the poles of the magnet; revealed the law that unlike magnetic poles mutually attract; showed how to detect the magnetic poles and demonstrated that in every part or fragment of a divided magnet the two poles persist. . . He invented the first mariner's compass which could be constantly used to steer by as we steer by its aid now, instead of being employed merely to indicate the direction of the Pole star; the first compass having a fiducial or 'lubber's' point and a graduated scale; the first compass capable of being used to measure azimuth or bearing; the first compass having a pivoted needle—the prototype of all electrical measuring instruments in which such an indicator is employed. . . Finally he first suggested the conversion of magnetic (electric) energy into mechanical energy in an organized machine and to do useful work; and thus he proposed the first magnetic (electric) motor. . . (moreover) by direct inspiration from his writings came the discovery of the dip or inclination of the compass needle, and the still more definite recognition of a magnetic field of force. . .

33½. A Letter from Dr. Wallis to Captain Edmund Halley. Dated Oxford, May 23, 1702. The Philosophical Transactions of the Royal Society of London, Vol. xxiii, No. 278.
34. "Electrical World and Engineer," New York, February 23, 1901.
35. "De Natura Rerum." Alexander Neckam. London (about) 1190.
36. "De Utensilibus." Alexander Neckam. London, (about) 1190.
37. "Dictionary of National Biography." Edited by Sidney Lee. New York, 1894.
38. "Anglo-Saxon and Old English Vocabularies." Thomas Wright. Second Edition. London, 1884.
39. "The Encyclopaedia Brittannica." Ninth Edition. New York, 1878.
40. "Prehistoric Structures of Central America: Who Erected Them?" M. I. Townsend. Troy, 1895.
41. "The Holy Bible; The Acts of the Apostles," xxviii:12.

The few manuscripts copies which had been made of this famous letter lay buried in the monasteries for nearly three hundred years," and this very isolation of the deductions and suggestions offered by Peregrinus enabled a number of writers to blunderingly plagiarize the fruits of his labor.

In the year 1544 "some important contributions to the accurate observation of magnetic phenomena were made by George Hartmann, Vicar of S. Sebald's, Nuremberg. In a letter to Duke Albert of Prussia, dated March 4, 1544. Hartmann describes some magnetic experiments that he had shown in the previous year to King Ferdinand of Bohemia, brother of Charles V., from which it appears that he was acquainted with magnetic repulsion as well as attraction, and knew that like poles repel, while unlike poles attract, each other; also that he had observed, contrary to the general belief of the time, that when one end of a compass-needle is stroked with a pole of a given kind, it acquires a polarity opposite to that of the pole employed; and further, that he not only knew that the variation of the compass was different in different places, but that he had discovered magnetic dip. . . But the first tolerably accurate measurement of the magnetic dip is due to Robert Norman, an English instrument maker, who, in 1576, found the dip in London to be 71° 50'."[42]

"That Hartmann was familiar," says Benjamin, "with the writings of Peregrinus," is indicated in this same letter wherein he says: '"I have received an old parchment book of the time of the wars of the Contadini, in which I have found mentioned the force of a magnet.' . . Peregrinus undoubtedly discovered the inclination of the needle to a globular magnet, but not to the earth. Hartmann discovered the inclination of the needle to the earth, but as his needle was arranged on a vertical, instead of a horizontal pivot it was impeded in inclining, hence he never saw the full extent of the angle of dip."[43]

Nearly three hundred years after Peregrinus penned that now famous letter, Pietro Sarpi, better known to the world by his monastic name of Fra Paolo Sarpi, and who became "the greatest genius of his age," was born in Venice on the fourteenth day of August, 1552. In early life Sarpi joined the Order of the Servites in "the monastery which stood just beyond the bridge of the Campo di Santa Fosca, in Venice."[44] After his death, which occurred in the year 1623, a manuscript treatise on the magnet was found wherein Sarpi describes the result attained by earlier writers, and then in enumerating his own experiments, is the first to record "the existence of the field of force around the magnetic poles," of the demagnetization of iron by heat, and of "the magnetization of iron by means other than induction from a lodestone."[45]

Robertson claims[46] that "Sarpi corresponded with William Gilbert, the eminent physician, and forstalled the theory developed in his work 'De Magnete', that the earth is a great magnet. Gilbert bears testimony to Fra Paolo's knowledge of magnetism, setting him above Porta, a distinguished Neapolitan professor of this science."

This "Neapolitan professor" was John Baptista Porta, an intimate friend of Sarpi's, and the eminent natural philosopher who, in A. D. 1560, established in Naples, the first Italian society for the advancement of physical science, and was the first president of the society. In 1558, when only sixteen years of age, Porta published a work on Natural Magic, in four books. In 1589, he issued a revised and enlarged edition consisting of twenty books, and the seventh book[47] in this edition is devoted wholly to the magnet. Now the contents of the seventh book appears to be largely a restatement of the discoveries and experiments of Peregrinus, as elaborated by Sarpi during his visits with Porta; for a manuscript copy of Peregrinus' letter was at Sarpi's service in the Castellan Library in Venice. And Porta frankly admits his indebtedness to Sarpi in his statement: "I do not blush, but confess myself honored to confess that many things concerning magnetic phenomena I have learned from Fra Paolo, a true ornament of light, not only of Venice, but of Italy and of the whole world."[48]

But Porta's seventh book contains one suggestion that may be the beginning of the efforts that finally culminated in the development of what Carlyle calls the "pulse of speech. . . the greatest blessing that science has given to civilization." In fact, Porta really foreshadows a wireless magnetic method of long-distance communication when he wrote in his seventh book: "To a friend, who is at far distance from us, fast shut up in prison, we may relate our minds; which I do not doubt may be done by two mariner's compasses having the alphabet writ about them."

Park Benjamin believes that "this is the first known suggestion of a possibility which fretted men's minds for many years; namely, that by reason of a supposed sympathy between magnets, the movements of one would be copied by those of another, no matter how great the distance between them; and that hence, it was necessary only to dispose alphabets around two widely-separated pivoted needles which had both been magnetized by the same lodestone, to cause the letter to which the needle at one station is moved to be indicated simultaneously by the needle at the other and distant station. Of course, this would now be termed telegraphy; and it would not be difficult to find modern dial telegraph instruments operating in accordance with a very similar process."[49]

Benjamin also relates how "Porta's idea appears to have been improved upon by Daniel Schwenter, who, in 1600, devised an apparatus of some complexity. He divided the compass card, in each of the widely-separated compasses, into compartments each containing four letters of the alphabet. The needles in signalling was intended to move first to the compartment containing the letter, and then to indicate the especial character desired by one, two, three or four vibrations. . . Just how the needles were to be worked by the bar magnets employed is not clear; but attention was to be called by the needle striking against a small bell placed in its path." However, in 1636, Schwenter, who wrote under the name of Johannes Hercules de Sunde, depreciates the commercial value of his device by writing that "this is a pretty invention; but I do not believe a magnet of such power could be found in the whole world."[50]

Possibly this change in Schwenter's valuation of his invention, may have been brought about by the humorous skit written four years previously by the celebrated astronomer, Galileo, who, in 1632, makes Gian Francisco Sagredo,[51] "who was the Venetian Consul at Aleppo in about 1610," say: "You remind me of one who offered to sell me a secret art, by which, through the attraction of a certain magnet needle it would be possible to converse across a space of two or three thousand miles. And I said to him that I would willingly become the purchaser, provided only that I might first make a trial of the art, and that it would be sufficient for the purpose if I were to place myself in one corner of the sofa and he in the other. He replied that, in so short a distance, the action would be scarcely discernible; so I dismissed the fellow, and said that it was not convenient for me just then to travel into Egypt or Muscovy for the purpose of trying the experiment, but that if he chose to go there himself I would remain in Venice and attend to the rest."[52]

Three years prior to Galileo's skit, Father Nicolas Cabeaus, explained that "the action by which compass needles are mutually disturbed is not brought about by sympathy, as some persons imagine, who consider sympathy to be a certain agreement, or conformity between natures or bodies which may be established without any communication.

42. "Handbook to the Special Loan Collection of Scientific Apparatus, 1876: Magnetic Apparatus. G. Carey Foster. London, 1877.

43. "Fra Paola Sarpi." Alexander Robertson. Second Edition, London, 1894.

44. "Jo Baptista Portae, Neapolitani: Magiae Naturalis, libri xx. Neapoli, 1589. (Natural Magic (English Translation) 1658, Book vii).

45. "Delicias Physico Mathematicae." Johannes Hercules de Sunde. Nurnberg, 1636.

46. "Dialogus de Systemati Mundi." Galileo. Florenza, 1632.

47. "The History and Progress of the Electric Telegraph." Robert Sabine. Second Edition. New York, 1869.

Magnetic attractions and repulsions are physical actions which take place through the instrumentality of a certain quality, or condition, of the intervening space, and which extends from the influencing body to the influenced body. I cannot admit any other mode of action in magnetic phenomena; nor have I ever seen in the whole circle of the science any (such) instance of sympathy."[48]

Before we ridicule these ancient and seemingly impracticable methods of so-called magnetic communication, let us not forget how our forefathers derided and sneered at the glorious achievements of Wheatstone and Morse, of Field and Bell. For men are yet living who publicly declared the plans of Cyrus W. Field to connect England and America with a deep-sea cable to be of the most foolish, visionary and impracticable character; who offered no helping hand during the twelve years of unceasing toil that slowly passed before Field's dream became a reality and "by his cable moored the New World close along the Old," yet tried to rob him of justly earned fame when the world was reaping the fruits of his labor.[49]

Nearly fifty years after Porta's suggestion of a wireless magnetic method of communication was published, an English philosopher, Sir Thomas Browne, who believed "that the mortalest enemy unto knowledge, and that which hath done the greatest execution upon truth, hath been a peremptory adhesion unto authority, and more especially the establishing of our beliefs upon the dictates of antiquity," and that it was prudent and wise to make "those infallible experiments and those assured determinations which the subject sometime requireth," made a series of experiments to determine to his own satisfaction how much truth there was in this supposed sympathetic attraction of one magnet for another magnet, and if there was an unrecognized scope and power in the magnetic field extending over an almost limitless area. After a thorough trial he expresses the opinion[50] that while "the conceit is excellent, and if the effect would follow somewhat divine. . . yet of these two compasses, whensoever I remove the one although but the distance of half a span, the other would. . . have no motion at all." As Browne's book had a wide circulation in England and on the continent, his statement no doubt did give "its quietus to Porta's ingenious conjecture" in so far as occult or sympathetic influence was concerned, "but not to the idea which was the life and soul of it," that a practical method would yet be devised by which men would be able to converse with one another though separated by many leagues. This constant recurrence to the possibility is evidenced in the observations that follow. For in these crudely constructed compasses lay the germ of the marvelous systems of magnetic and electric communication that have practically annihilated the factor of distance, and enable the people of one nation to instantly convey thought and desire unto the people of another nation, though the seas intervene. Were Galileo now in Venice and Sagredo in Moscow it would be a simple matter to converse over long-distance lines as easily as though "I were to place myself in one corner of the sofa and he in the other." The idea of distant communication was there, and was bound to be successfully evolved, treated with contempt by the greatest intellects of that age though the idea was; and the method, the means, the apparatus were being slowly, often unconsciously brought to a condition where the world could utilize them. For, as Robert Sabine, the well-known telegraph engineer has well said, "some means of rapid communication is, and probably always has been, not only a necessity, but an accomplished fact, in some form or other. . . It is not in the first conception of this idea that so much credit lies, as in its gradual development into the proportions of a reality. How long a way to attain this may have been struggling for birth in thinking minds of past centuries, it is now impossible even to imagine."[50]

48. "Philosophia Magnetica." Nicholas Cabaeus. Coloniae. 1629.
49. "The Story of the Atlantic Telegraph." Henry M. Field. New York. 1893.
50. "Enquiries into very many received tenets and commonly presumed truths, which examined prove but Vulgar and Common Errors." Thomas Browne. London. 1646.

But it only requires a glance over the long "list of authors of the sixteenth, seventeenth and eighteenth centuries, who either describe the sympathetic needle and sympathetic flesh telegraphs, or make a passing allusion to one or both of them," which Fahie gives,[51] to perceive how highly the value of a means of communicating over long distances was appreciated.

And following the announcement from the Lowell Observatory at Flagstaff, in Arizona, "that a shaft of light had been seen to project from the planet Mars, lasting seventy minutes," Nikola Tesla declared[52] that while "the idea of communicating with the inhabitants of other worlds is an old one . . . it seems as if it were destined to become the dominating idea of the century that has just begun. At the present stage of progress, there would be no insurmountable obstacle in constructing a machine capable of conveying messages to Mars, nor would there be any great difficulty in recording signals transmitted to us by the inhabitants of that planet, if they be skilled electricians. Communications once established, even in the simplest way, as by a mere interchange of numbers, the progress toward more intelligible communication would be rapid," and he explained why he does not coincide with Dr. Holden and other scientists who hold "that it is plain to all that we have the right to conclude that there is not the slightest reason to believe that human life can exist on the planet Mars."[53]

But to return to the evolutions of the magnetic method of speech transmission, and the medieval myth of the compass method of communication. Commenting on Browne's decision that it was improbable that any influence should effect a compass "at a distance which nearer at hand it cannot at all perform," Joseph Glanvill, "an acute, an original, and in matters of science, a somewhat sceptical genius," wrote a series of essays[54] one or two paragraphs in which are now claimed to contain curious anticipation of the electric telegraph. In 1665, Glanvill wrote:[55] "To them that come after us it may be as ordinary to buy a pair of wings to fly into the remotest regions as now a pair of boots to ride a journey. And to confer at the distance of the Indies by sympathetic conveyances may be as usual to future times as to us in a literary correspondence . . . a couple of needles equally touched by the same magnet being set in two dials exactly proportioned to each other, and circumscribed by the letters of the alphabet, may effect this magnet hath considerable authorities to avouch it. . . . Now, though this desirable effect possibly may not yet answer the expectation of inquisitive experiment, yet 'tis no despicable item, that by some other such way of magnetic efficiency it may hereafter with success be attempted, when magical history shall be enlarged by riper inspections, and is not unlikely but that present discoveries might be improved to the performance."

And in the light of our present knowledge of the art of telephony, does this prediction of Glanvill's in 1665, that we may by "some other way of magnetic efficiency confer at the distance of the Indies," appear as unreasonable as the "very reasonable statement" made before a learned society in London, two hundred and twenty years later by William H. Preece, engineer-in-chief and electrician of the telegraph departments of the English postoffice, and "the first constructor of a practical wireless telegraph?"[56] In 1884, Mr. Preece said: "Although this short paper is confined to a description of a simple system of communicating across terrestrial space, one cannot help speculating as to what may occur through planetary space. Strange mysterious sounds are heard all along telephone lines when the earth is used as a return, especially in the calm stillness of night. Earth cur-

51. "A History of Electric Telegraphy to the year 1837." J. J. Fahie. London. 1884.
52. "Talking with the Planets." Nikola Tesla. Collier's Weekly, New York. February 9, 1901.
53. "What We Know About Mars." Edward S. Holden. McClure's Magazine. New York. March, 1901.
54. "The Vanity of Dogmatizing, and an Apology for Philosophy." Joseph Glanvill. London. 1661.
55. "Scepsis Scientifica, or Confest Ignorance the way of Science." Joseph Glanvill. London. 1665.
56. "A History of Wireless Telegraphy. 1838-1899." J. J. Fahie. Edinburg and New York. 1899.

rents are found in telegraph circuits, and the Aurora Borealis lights up our northern sky when the sun's photosphere is disturbed by spots. The sun's surface must at such times be violently disturbed by electrical storms, and if oscillations are set up and radiated through space, in sympathy with those required to effect telephones, *it is not a wild dream to say that we may hear on this earth a thunderstorm in the sun.* If any of the planets be populated with beings like ourselves, having the gift of language and the knowledge to adapt the great forces of nature to their wants, then if they could oscillate immense stores of electrical energy to and fro in telegraphic order, it would be possible for us to hold *commune by telephone with the people of Mars."*

Under date of Yeovell, October 12, 1670, Dr. John Beale, wrote a letter to the Honorable Robert Boyle, in which he touched upon several subjects, and then gives expression to his belief that some day communication over long distances would be brought about, but whether through a system of telepathy or telegraphy or telephony, the reader may determine. "In words which sound like those of a seer."[57] Dr. Beale wrote: "Whatever the way, or the manner or the means of it be, we are sure that we have a perception at great distance, and otherwise, than by our own senses; and sometimes a secret anticipation of things future, which cannot be without correspondence with some causative, whether aerial, more refinedly etheral, intelligent, or astral; whether by any one or other; or all of these expedients, we are sure of the great and strange effects; and when we see how quickly the sunbeams do pass to the borders of this vertex, we may well imagine that our spirits may hold an intercourse at like distance, with equal dispatch, in mental and spiritual affairs."[58]

If Dr. Beale's words "sound like those of a seer," how shall we class the address of the chief engineer of a great telephone company, "a practical man of science," who three hundred and thirty-one years later said: "We are like ships that pass each other on the ocean. To them wireless telegraphy is most useful. Who can say that the next ten years may not see thought transmitted from man to man at a distance in the same mysterious manner and without sound waves or light waves or electric waves? It is possible that our brains are centers of energy, which, like an electric generator, send out currents through some unknown medium."[59]

Or was Dr. Beale's statement so widely divergent from that of Professor Aryton, who in a lecture on submarine telegraphy, at the Imperial Institute, in London, in February, 1897, said: "I have told you about the past and about the present. What about the future? Well, there is no doubt the day will come, maybe when you and I are forgotten, when copper wires, gutta-percha coverings and iron sheathings will be relegated to the Museum of Antiquities. Then when a person wants to telegraph to a friend, he knows not where, he will call in an electro-magnetic voice, which will be heard loud by him who has the electro-magnetic ear, but will be silent to every one else, he will call, "Where are you?" and the reply will come, loud to the man with the electro-magnetic ear, 'I am at the bottom of the coal mine or crossing the Andes or in the middle of the Pacific;' or perhaps no voice will come at all, and he may then expect the friend is dead. Think what that will mean. Think of the calling which goes on from room to room, then think of that calling when it extends from pole to pole—a calling quite audible to him who wants to hear, absolutely silent to him who does not."[60]

Kingston has admirably crystallized all these speculations, experiments and realizations, in a single paragraph: "Away back from the dim and distant past you may see a long line of men reaching up to a time almost linked with the present by the span of a single human life, standing patiently by their watch-towers, waiting eagerly for the 'pillar of cloud by day and the pillar of fire by night,' to spell out for them in crude, imperfect warnings, symbols of danger or of opportunity, of victory or defeat, as did the old watchman, who waited for ten long years on the tower of Agamemnon's palace for the 'blazing torch' which was to signal the fall of Troy. Around you to-day the near descendants of the men who lit the beacon-fires are sending waves of thought around the world, to be caught up by sympathetic instruments without any visible contact, and you think of the coming time when, without any great stretch of imagination, everyone will be able to send, not only a telegram, not only a telegraphic portrait, to a distant friend through space, but when every man, for aught we know, may carry in his pocket his own 'sympathetic' receiver, by opening which and applying it to his ear he may listen to the gossip of the world, as the shell picked up on the seashore repeats the whispering music of the ocean; with this difference; that he will be able to select from the myriads of ether-waves the particular message intended for himself alone."[60]

THE TELEPHONE AS AN INDUSTRIAL FACTOR.

Invention is full of romance. No man examining the first telephone could possibly have foreseen either the extent of the industry which has grown up as the result of the invention of this apparatus, or even dimly have conceived the industrial importance of the new means of communication, says the Electrical Review. The telephone is now but twenty-five years old and in its short lifetime it has made a new industry of gigantic proportions and has been a benefit to the entire community of such magnitude that it is not possible even now to comprehend fully the debt we owe to the instrument and its inventors.

When announcement was made of the invention of an electrical machine that would permit speech to be carried on at great distances over a wire, it was received at first with absolute incredulity. A little later the attitude of the public mind toward the telephone was that it was an exceedingly interesting thing but of limited usefulness. No one can truly judge to-day how useful it has been or how much it has done, because it is hard to conceive of the condition of industry, society and commerce had the telephone not been invented and put in use when it was.

Certain concrete facts, however, can be established in connection with it which show that as an industrial factor the telephone has been of almost supreme importance. In the first place, the industry of telephone operation and manufacture has enlisted investment of enormous sums of capital upon which interest is earned and paid, and has given employment to hundreds of thousands of people in a remunerative and important industry. More than this, however, the use of the telephone by the general public has worked such marvelous transformations in methods of business as to inaugurate practically a new era in the conduct of ordinary affairs.

The only other thing with which the telephone can reasonably be compared is the inauguration of cheap postal rates, making communication between the citizens of different parts of the country easy and inexpensive. The stimulation of internal and external commerce which was due to this innovation will probably never be realized to its fullest extent, since we have no conception of what conditions would be at present without these facilities. It is so with the telephone, but one or two points are self-evident. One is that a vast amount of the lifetime of the human race has been saved by the instantaneous interchange of intelligence possible through the agency of the telephone wire. If it were possible to imagine the business of a great city to-day to be deprived of telephone facilities it is at once evident that an enormous number of messengers would be required, and that all sorts of business would be shackled and circum-

57. "The Works of the Honorable Robert Boyle." Vol. vi. London. 1772.
58. "Telephony." Chicago. April, 1901.
59. "Sixty years of Submarine Telegraphy." Prof. W. E. Ayrton. The Electrician. London, February 19, 1897.
60. "The Romance of a Hundred Years." Alfred Kingston. London. 1901.

scribed by the difficulty of communication. It is impossible to compute the general benefit that has resulted from the instantaneous and easy exchange of intelligence that the telephone has made possible.

While the value of telephones in purely local affairs is enormous, the importance of the long-distance telephone is almost equally great. To take a simple case, many business transactions between New York and Philadelphia, for example, which formerly required personal visits consuming the whole of one man's time for at least a day and costing a considerable sum for railway fare and expenses, may now be concluded almost instantaneously, without loss of time and at very reasonable rates, over the telephone. It is an encouraging and interesting fact that the variety of business thus transacted is increasing and that the volume of long-distance traffic is augmenting at a great rate every year. The longer the distance, other things being equal, the more valuable is the opportunity afforded by the telephone for immediate correspondence.

Taking together all of the factors, it is perhaps truthful to-day that the telephone has been one of the most important single additions to the general equipment of the industrial world that has ever been made. And perhaps the most interesting phase of the present telephone situation is that the industry is evidently only at the beginning of an extended growth. What has been done in twenty-five years is sufficiently astonishing; what will be done in the next twenty-five years staggers the imagination.

DECISIONS AFFECTING TELEPHONY.

PREPARED FOR TELEPHONY BY ANDREWS & MURDOCH, BERRIEN SPRINGS, MICH.

NEGLIGENTLY ATTACHING WIRE TO CHIMNEY.

The New York Telephone Company, in stringing its wires in the city of New York, passed one of its wires around an old brick chimney that arose from the roof of a building. A derrick which was being used in the construction of a building near by, struck the wire, which caused it to pull down the chimney, and from the flying debris Florence S. Leeds was injured. She brought suit for damages against the telephone company, alleging negligence on the part of the company in attaching its wire to the chimney. The court held that the facts stated constituted a sufficient showing of negligence on the part of the company to entitle her to a trial on the merits.

RIGHTS TO USE OF STREETS UNDER CONFLICTING GRANTS.

The United States Circuit Court, in the case of Cumberland Telephone & Telegraph Company vs. Louisville Home Telephone Company held that, where a city has granted to each of two telephone companies the right to construct its line on the same side of the same street, neither grant being exclusive, in the absence of any statute or ordinance regulating the construction and operation of such lines the company which is prior in grant and in occupancy has the superior right, and the second company is not entitled to plant its poles within the space previously occupied by the first company, so that they will extend up through its wires, or to occupy with its own wires the space beneath them, where it will impair the safety or interfere with the efficient operation of the first line.

INJURIES OCCASIONED BY CONTACT OF WIRES WITH THOSE OF ELECTRIC LIGHT COMPANY.

A lineman of a telegraph company was ordered to "clear" a line from which there was a leakage of the electric current. For this purpose he climbed a telegraph pole, and while so doing his hand came in contact with one of the wires strung on the pole, from which he received a shock that killed him. The wires were supposed to carry but a low voltage and not to be dangerous. A short distance from the pole the wires were crossed by the wires of an electric light company, one of which had sagged so as to touch the telegraph wires, and the generation of the high current therefrom had caused the death. A short time prior to the accident there had been a storm that may have contributed to the sagging of the electric light wire, but the storm had not been of exceptional violence. In an action against the electric light company for the wrongful death of the lineman, the court held, 72 N. Y. Supp., 279, that the electric light company was negligent in not stringing its wires at such a height as to avoid liability of contact with the telegraph wires through sagging induced by ordinary causes, and it also held that the lineman operating on wires supposed to carry but low voltage, was not negligent in failing to test the wires before taking hold of them.

LICENSE TO USE STREETS—ASSIGNMENT.

In reviewing a judgment in favor of the Union Telephone Company, in a suit against it to compel it to discontinue the use of the streets of Pontiac, Ill., for the operation of its telephone system, the Supreme Court of Illinois, 61 N. E. Rep., 428, says that a municipal grant of the right to use streets for telephone poles, and the operation of a telephone system, though not a franchise, becomes when the privileges granted are accepted, a binding contract between the city and the telephone company, which cannot be revoked or rescinded except for cause, and that where such grant is to the telephone company, "its successors and assigns," that such right is assignable.

DAMAGES IN CONDEMNATION PROCEEDINGS.

A judgment against the Board of Trade Telephone Company, awarding excessive damages in a condemnation suit, has been set aside by the Supreme Court of Illinois. R. M. Darst, in front of whose place the telephone line was extended along the side of the highway for sixty rods, claimed damages in a suit condemning the land for the placing of the poles. The jury awarded him $300 as damages to his property, aside from the amount awarded for the land actually taken. In his claim for damages Darst asked to be recompensed for the cost of construction and maintenance of a fence deemed necessary by the erection of the line, which he placed at $39 every ten years for one hundred years. The court held this claim for damages was too problematical and that Darst could only claim the amount which would compensate him for the depreciation in value of the land by reason of the erection of the line.

THE OPERATING FORCES OF MODERN TELEPHONE EXCHANGES.

BY HARRY S. COYLE.

The telephone operator is no small factor in considering exchange work. Mr. Stanton tells us among many other important and interesting facts in his address, delivered at the fifth annual Independent Telephone Convention, "that the operating force of a large exchange is of the utmost importance, especially in its relation to the public."

It was in 1883 that the American Bell Telephone Company first tried the experiment of employing girls as operators, which we know has been highly successful. It is only in recent years that women have been employed in any considerable number in public service. It is now generally recognized that they can perform successfully the duties of many of the subordinate places, and they have often shown eminent fitness and high quality in performing their duties. Nowhere is this fact more apparent than in the telephone exchange, and I think the telephone has accomplished more to elevate her public position and show her true worth than any other field of occupation that I know of.

Very few people in the telephone field, outside of the exchange, really know what the duties of a telephone operator are. If such would take a seat at the switchboard some morning at 7 o'clock and remain there until 5 p. m., he would be astonished at the store of information that most operators possess, and the perfect discipline that is maintained in operating the exchange.

It is an old, but a true saying that the hand that operates the switchboard rules the dominion of telephony. The success of a telephone company depends upon the grade of service it renders to the public, and the perfection of this service (granted that the mechanism of the plant is in good working order) depends upon the skill and quickness of the operators in answering the subscriber and securing his wants.

Here in Cleveland the operators of the Cuyahoga Telephone Company are instructed in every form of service which would increase the popularity of the company among its patrons. For example: When a subscriber "calls up" and the operator finds the wanted line busy, she asks permission to call the subscriber as soon as the party he wanted has hung up his receiver, and this permission is readily granted, and does more to increase the good-will of the public for the welfare of the company than any other form of service I know of. Little courtesies like this cost nothing, and no company should allow its operators to become so busy as to interfere with their duties to the public in this respect. What the public desires is promptness of service and courtesy in dispensing the same. All girls do not become successful as telephone operators. The attributes requisite for a successful operator are not many to be sure, but many girls have found to their sorrow that they are deficient in those qualities which are essential to the making of a successful telephone operator. The telephone operator, like the telegraph operator, must have a good stock of common sense, and must give unrelaxing attention to her duties, and above all, be of a strong nervous temperament. Half of the failures of novices as telephone operators may be traced to a disordered nervous system. It is a trying ordeal on the delicate nervous system of a girl to set at the switchboard and patiently perform her duties from day to day, which are by no means a "cinch."

Dr. Gellé a distinguished French aurist, who has made an exhaustive study of the effects of the telephone upon the operator's ears, says that operators frequently present a series of aural disturbances similar to those resulting from the continued action of loud noises. In such cases there may be found irritable conditions of the nervous apparatus of the ear, or there may exist an inflammation of the membrana tympani and of the tympanic cavity. Such disturbances generally lead to grave nervous disorders of the entire system. In cases observed there were pains in the ear, diminished hearing, subjective noises, hyperesthesia acoustica and vertigo, all of which were manifested at first during loud auditory impressions, but later becoming permanent, with general nervous irritability. It is, of course, needless to say that there must be a predisposition for the production of the above disturbances which are due to a greater excitability of the entire nervous system, or to a previous and still existing disease of the ears. Every telephone company should have candidates for operators examined by a physician, and reject all that are in the least predisposed to ear, eye or vocal disorders. If we find an operator who is cross and discourteous to subscribers we must remember that it is her situation which has made her so. She has accepted a position which she is incompetent physically to fill with credit to herself and to her employers.

If one would take the trouble to watch the movements of the operators in performing their duties he would observe that the movements of one operator corresponds with the movements of the entire force in performing a given task.

Operators are not permitted to use their own judgment as to how this or that task is to be performed, however insignificant this task may appear, but they are governed by a system of rules which have been suggested by years of experimentation in exchange practice. To be efficient such rules must be rigidly enforced, and, like the laws of the Persians and Medes, must be unalterable, and applied to all alike. Every telephone operator understanding the rules governing the movements of the hands in handling the cords and in inserting the plug into the calling and answering jacks. Every movement that an operator performs in operating the switchboard is governed by a rule which she must learn before she is permitted to take her seat at the switchboard as an operator.

Operators are taught how to answer the calls in a firm but courteous voice, and what words to use in speaking to the public.

There is nothing left to the judgment of the operators but to familiarize themselves with the rules of the exchange, and to obey the same. Notwithstanding all of this, the operators of small exchanges are at all times in touch with many classes of people whose wants are so varied that it is impossible to govern the operator in fulfilling the same. In large exchanges the chief operator, the trouble clerk and the free information bureau take care of all of the public's wants outside of the regular routine duties of the operator.

The operator must be fleet of motion, nimble of finger and almost instantaneous in mental action. She must be so trained in the use of her voice that the subscriber will know that he is dealing with a disciplined person; there must be no hesitating in answering a business man's call. The operator should answer all calls in a firm but courteous manner, and avoid all controversies with the public by switching the same over to the chief operator, or to the trouble clerk. It takes considerable skill and patience on the part of the beginner to master the art of telephone operating. What would be more terrifying to the novice at telephone operating than to have some number of the fourth denomination with letters prefixed and suffixed rushed into her ear with lightning like rapidity by a stern and commanding voice at the other end of the line! To be able to find this number, which is placed among five thousand others on some of our large multiple switchboards, at the rate that is required of operators by telephone companies, requires no little ingenuity and experience. Then again, the operator must have a good memory and be able to use her knowledge of the business without referring to notes. To neglect to call a subscriber at the hour he desired to be called would in all probability cost her her situation.

It is a daily occurrence for subscribers to have their numbers changed. This the operator must remember and when a party calls for this number the operator must notify the party that this number has been transferred to a new subscriber.

The night service of most all exchanges where girls are employed is very poor, and oftentimes it is almost impossible to raise the switchboard at all. The only remedy for this evil is to employ men. Two men could easily handle two thousand lines at night, and possibly more. The Bell employs men operators at night in some of our large cities, and their night service is very efficient. It is not right to ask a girl to imperil her health and to deny herself of almost all pleasure by working at night. Even if she does work at night, she finds it impossible to do justice to herself and to her employers.

The telephone operator represents the highest type of the American girl, for it is only the best and brightest of girls that are successful as operators. The art of telephone operating is no insignificant one in its relation to general telephony, for it is the operator who is at all times in constant touch with an over-exacting and ever-criticizing public and she bears the whole brunt and blame of a defective telephone system. The telephone operator has, to a great extent, created her own environment, proven her own worth and has gained for herself an indispensable position in the sphere of telephony.

"We are very much pleased with your production and shall be pleased to be considered as permanent subscribers thereto.

C. O. TRASK, Gen'l Mgr.,
Union Telephone Co.,
Alma, Mich."

RULES AND SPECIFICATIONS FOR THE CONSTRUCTION OF TELEPHONE TOLL LINES AND FARMERS' CIRCUITS.

BY W. H. CRUMB.

GENERAL.

1. SELECTION OF ROUTE. When it is decided to build a toll line between two places, the most direct system of highways which reaches the important intermediate points should be selected for the route of the line. An inspection of the available routes should be made in order that the one chosen may be as free as possible from curves and turns, electric light, railway and other electrical interferences. It is often found advisable to cross private property to avoid abrupt turns, long detours or other serious objections.

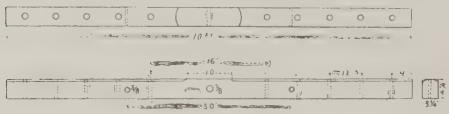

FIG. 1—TEN-PIN CROSS-ARM.

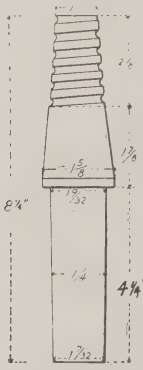

FIG. 3—TRANSPOSITION PIN.

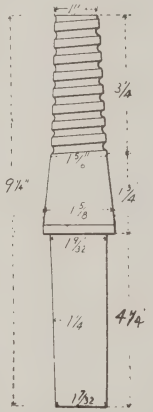

FIG. 2—STANDARD PIN.

2. RIGHT OF WAY. All laws, ordinances and regulations prescribed by county, township, city or village authorities, relative to the use of the highways, must be strictly complied with and proper permits and privileges secured before commencing the construction of the line. In order to establish a permanent right of way, it is necessary to secure a formal right of way and tree-trimming permit from each abutting property owner, except within the limits of incorporated villages and towns. In no case should poles be set on private property without the written consent of the owner.

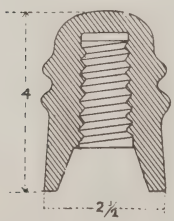

FIG. 5—TRANSPOSITION INSULATOR.

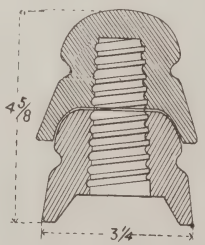

FIG. 4—STANDARD INSULATOR.

3. POLES PER MILE AND KIND OF WIRE. These specifications are prepared for a 25-foot pole line, 35 poles per mile, with one ten-pin crossarm and No. 10 B. & S. copper metallic circuits; this can, however, be varied to suit local conditions. For short local circuits (less than fifty miles), No. 9 E. B. B. iron wire upon six-pin crossarms, where three or less circuits are necessary, will give excellent results. In all cases where the circuit is a "through one" or is to be used in connection with a "through one," No. 10 B. & S. copper wire should be used.

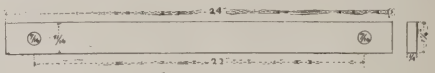

FIG. 6—CROSS-ARM BRACE.

Thirty-five poles per mile is sufficiently strong for five metallic circuits (ten wires), but if two or more ten-pin crossarms are required, forty poles per mile should be used. For circuits exceeding five hundred miles in length larger copper wire should be used.

4. SUPERVISION OF WORK. All work pertaining to the construction of the line will be supervised and directed by a superintendent of construction, from whom the foremen in charge will receive their detailed orders, and a copy of these specifications.

5. WAGES AND HOURS OF LABOR. The rate of wages and hours of labor will be regulated by the superintendent of construction. It is customary on toll line work for the employer to pay for the board of the employes.

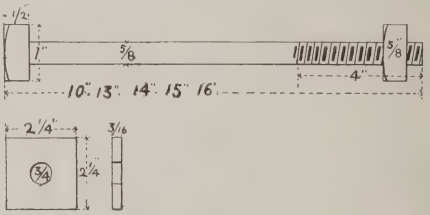

FIG. 7—MACHINE BOLT.

6. DISBURSEMENTS. The foreman in charge shall be provided with sufficient funds to meet current expenses, such as pay rolls, freight and board bills, discharged labor, etc.

In order to insure the employer against financial loss, the foreman should be bonded by some responsible guarantee company, in an amount to be decided by the superintendent of construction, the premium for the bond to be paid by the employer.

Foremen must pay all bills promptly and under no circumstances leave a place without settling all accounts.

7. REPORTS. Daily reports of progress of work, number of men employed, material needed, expenses and such other reports as may be required by the superintendent of construction shall be made by the foreman.

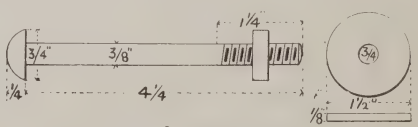

FIG. 8—CARRIAGE BOLT.

8. TOOLS. Each foreman will be furnished with a complete outfit of tools, except climbers, pliers and belts, which each lineman is required to furnish for himself. Foremen will be held responsible for all tools in their charge and must make monthly reports of tools on hand. All tools unaccounted for will be charged to the foreman.

9. UNLOADING AND STORING MATERIAL. A competent man must be placed in charge of unloading all material which is shipped for the construction of the line.

All cars should be unloaded promptly, so that there will be no demurrage charges.

Care must be taken that poles or other materials are not

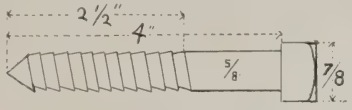

FIG. 9—FETTER DRIVE SCREW.

broken or damaged in handling. Copper wire and small material must be stored in a place of safety where it can remain until needed.

10. INSPECTING MATERIAL. All material received must be carefully inspected and checked with ship-

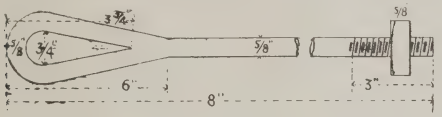

FIG. 10—GUY ROD.

ping notices and any material which does not conform to the following specifications or shortages must be promptly reported to the superintendent of construction.

11. ACCIDENTS. Any accident to employes while

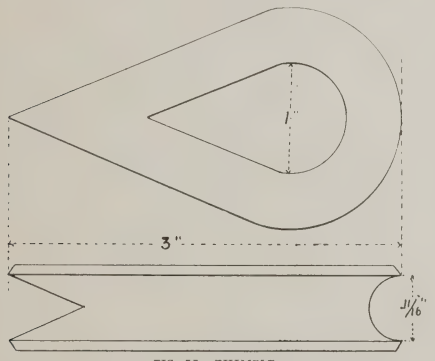

FIG. 11—THIMBLE

engaged in the performance of their work must be immediately reported to the superintendent of construction.

MATERIAL SPECIFICATIONS.

12. POLES. All poles must be of live white cedar, reasonably straight, squared at both ends, well proportioned from butt to top, peeled and have knots trimmed close. They shall be subject to the inspection of the purchaser at destination, and all poles which do not conform to the following specified requirements will be rejected:

Length.	Diameter at Top.	Circumference at Top Not Less Than	Circumference 6 Feet From, But Not Less Than
25 feet.	5 inches.	16 inches.	25 inches.
25 "	6 "	20 "	30 "
30 "	7 "	22 "	36 "
35 "	7 "	22 "	38 "
40 "	7 "	22 "	43 "
45 "	7 "	22 "	47 "
50 "	7 "	22 "	50 "

13. CROSSARMS. All crossarms shall be made of thoroughly seasoned, straight-grained, long-leaf yellow pine, free from sapwood, and such knots as will weaken them. They shall be 3¼ inches in thickness and 4¼ inches in height. Ten-pin crossarms shall be ten feet in length; six-pin crossarms shall be six feet in length. The top surface shall be chamfered throughout the whole length, except five inches on each side of the center; crossarms shall be vertically bored for 1¼-inch pins, the spacing between the pins nearest the center shall be 16 inches, between the other pins 12 inches, and there shall be a space of four inches

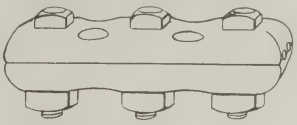

FIG. 12—THREE-BOLT CLAMP.

between the last pin on each side of the center and the end of the crossarm; they shall also be bored from side to side for one machine bolt in the exact center of crossarm, the bolt to be ⅝ of an inch in diameter; also for two carriage bolts ⅜ of an inch in diameter, one of these holes being on each side and 15 inches from the center of the face of the crossarm. They shall be thoroughly painted with a brush

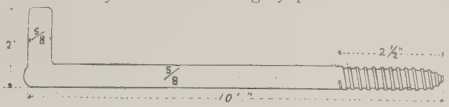

FIG. 13—POLE STEP.

and covered with two coats of Prince's metallic paint, mixed in the ratio of seven pounds dry paint to a quart of pure linseed oil. (See Fig. 1.)

14. PINS. The standard pin shall be of the best quality, sound, clear, split locust, free from knots and sapwood, 1¼ inches in diameter, 8¼ inches long and 4¼ inches from

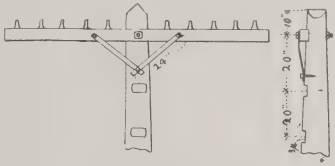

FIG. 14—POLE AND CROSS-ARM.

shoulder to bottom of pin, which shall taper, as in Fig. 2.

Transposition pins shall be the same as the standard pin, except that they shall be 5 inches from the shoulder to the top of the pin, as in Fig. 3.

15. INSULATORS. All insulators shall be of stand-

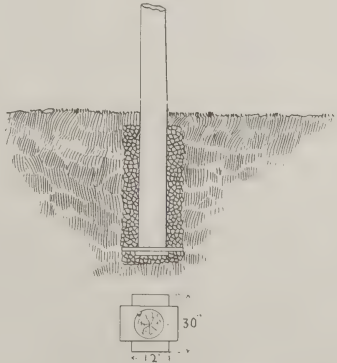

FIG. 15—POLE SET IN CONCRETE.

ard white glass, 2½ inches in diameter, 4 inches high and shall weigh 16 ounces each, as in Fig. 4.

For transpositions standard two-piece transposition in-

sulators, 3¼ inches by 4⅝ inches, as shown in Fig. 5, shall be used.

16. GALVANIZING. The galvanizing on all iron and steel work shall be sufficient to stand the following test, viz.:

The sample shall be immersed in a saturated solution of sulphate of copper and permitted to remain one minute, and then wiped dry. This process shall be repeated three times,

FIG. 16—FACING CROSS-ARM.

and if, after the fourth immersion, there should be a copper deposit on the sample, the lot from which the sample is taken shall be rejected.

The threads on all galvanized bolts shall be recut after galvanizing, i. e., the thread shall first be cut with a die somewhat smaller than standard, then galvanized, and recut with a die of standard size, which will leave a coating of zinc on the threads.

17. CROSSARM BRACES. Crossarm braces shall be of wrought iron or low carbon steel, galvanized, 1¼

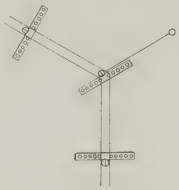

FIG. 17—SINGLE ANCHOR CORNER GUY.

inches wide, ¼ inch thick and 24 inches long, bored, as shown in Fig. 6.

18. BOLTS AND WASHERS. Crossarm bolts shall be galvanized iron machine bolts, ⅝ inches in diameter and from 10 to 16 inches long. Each bolt shall have threads cut 4 inches and be provided with two galvanized iron washers 2¼ inches square, 3-16 inch thick, with a ¾-inch hole in the center, as shown in Fig. 7.

Carriage bolts for crossarm braces shall be of galvanized iron ⅜ of an inch in diameter and 4¼ inches long. Each

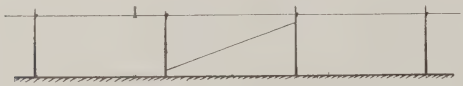

FIG. 18—HEAD GUY.

carriage bolt shall be provided with one galvanized iron round washer 1½ inches in diameter and ⅛ inch thick, with a ¾-inch hole in the center, as shown in Fig. 8.

19. FETTER DRIVE SCREWS. Fetter drive

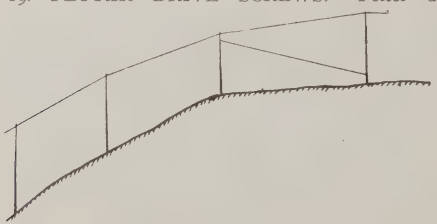

FIG. 19—HEAD GUY ON HILL.

screws shall be galvanized iron, 4 inches long by ⅝ of an inch in diameter, as shown in Fig. 9.

20. GUY RODS. Guy rods shall be of galvanized wrought iron, 8 feet long, ⅝ inch in diameter, with an eye at one end and a thread and nut at the other end, as shown in Fig. 10. Each guy rod shall be provided with a galvanized iron washer 2¼ inches square, 3-16 inch thick, with a ¾-inch hole in the center.

21. THIMBLES. All thimbles for guying shall be of galvanized iron 3-32 of an inch thick and 3 inches long, as shown in Fig. 11.

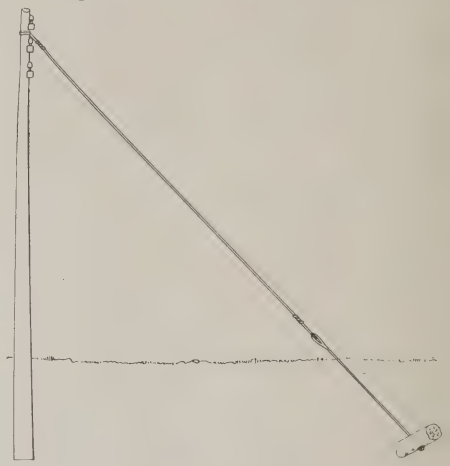

FIG. 20—ANCHOR GUY.

22. GUY CLAMPS. Guy clamps shall be of the pattern known as the "three-bolt clamp," and be made of the best quality of galvanized malleable iron. Each clamp shall be 5⅜ inches in length. The longitudinal curve of the grooves shall be the same in each half of each clamp, and each half shall be smoothed free from casting imperfections

FIG. 21—ANCHOR GUY.

and have three bolt holes 6-16 of an inch in diameter spaced 1⅞ inches between centers. The three bolts shall be 2¼ inches in length by 5-16 of an inch in diameter and shall be of the best quality of steel, with a breaking strain of at least 80,000 pounds per square inch. All threads shall be carefully recut after galvanizing. (See Fig. 12.)

23. POLE STEPS. All pole steps shall be made of galvanized iron, 10 inches long, ⅝ of an inch in diameter, as shown in Fig. 13.

24. HARD-DRAWN COPPER WIRE. Every coil of copper wire shall be drawn in one continuous length and be free from joints. The wire shall be cylindrical, free from scales, inequalities, flaws, splints and all other imperfections.

—C—

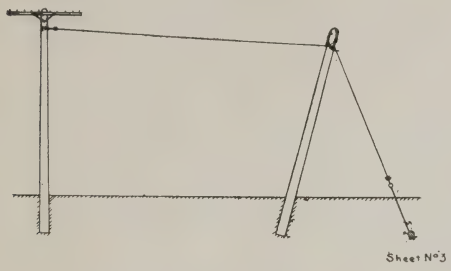

FIG. 22—GUY, STUB AND ANCHOR.

The coils shall be securely bound with at least four separate pieces of strong twine, and shall be protected by wrappings of burlap, such wrappings of burlap shall be placed upon the bundles after they have been properly secured by the twine. The diameter of the eye of the coil shall not be less than

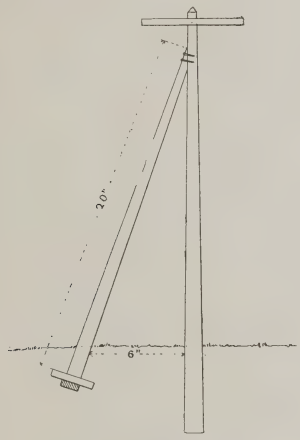

FIG. 23—POLE BRACE.

20 inches or more than 22 inches in diameter. Each coil shall have the weight and corresponding length plainly marked on two strong tags, one of such tags being attached to the coil inside, and the other outside of the burlap. The mechanical and electrical qualities must be in accordance with the following requirements:

Hard Drawn Copper Wire.	Number 10 B. & S. G.	Number 12 B. & S. G.
Diameter in mils:		
Required	101.9	80.0
Maximum	102.8	81.2
Minimum	101.0	79.3
Weight per mile, pounds:		
Required	165	102.6
Maximum	168	105.7
Minimum	162	100.8
Breaking weights, pounds:		
Actual required	540	334
Actual minimum	519	327
Per square inch	64,800	66,500
Weight of coils, pounds:		
Maximum	218	72
Minimum	152	52
Conductivity, per cent:		
Required	97	97
Minimum	96	96
Twists in six inches, number	40	44
Elongation in five feet, per cent	.99	.94

25. EXTRA B. B. IRON WIRE. All extra B. B. iron wire shall be soft and pliable, and capable of elongating 15 per cent without breaking, after being galvanized.

Great tensile strength is not required, but the wire must not break under a less strain than two and one-half times its weight in pounds per mile.

Tests for ductility will be made as follows: The piece of wire will be gripped by two vises, six inches apart, and

FIG. 24—ROAD CROSSING.

twisted. The full number of twists must be distinctly visible between the vises on the six-inch piece. The number of twists in a piece of six inches in length not to be under fifteen.

The weight per mile for the different gauge wires to be:

FIG. 25—ROAD CROSSING.

No. 6, 540 pounds; No. 8, 380 pounds; No. 9, 320 pounds; No. 10, 250 pounds or as near these figures as practicable.

The electrical resistance of the wire in ohms per mile, at a temperature of 68 degrees Fahrenheit, must not exceed

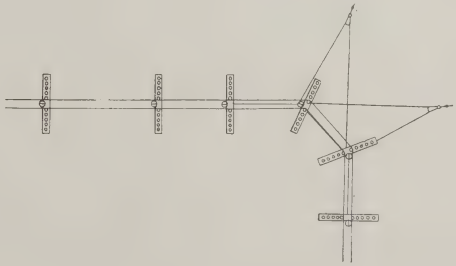

FIG. 26—CORNER GUY.

the quotient arising from dividing the constant number 4,800 by the weight of the wire in pounds per mile.

The wire must be well galvanized and capable of standing the galvanizing test shown in paragraph 16.

26. GUY STRAND. All guy strand shall be made of seven strands of No. 12 B. W. G. galvanized steel wire. Each strand shall be cylindrical and free from scales, flaws, splints and all other imperfections and defects. The wire

shall be capable of elongating 4 per cent without breaking, and, when clamped in vises 15 inches apart, shall stand fifteen twists without breaking. The wire shall not break when subjected to a strain of at least 4.3 times its weight in pounds per mile. The seven wires shall be laid with a right-hand lay, not exceeding 3½ inches in length.

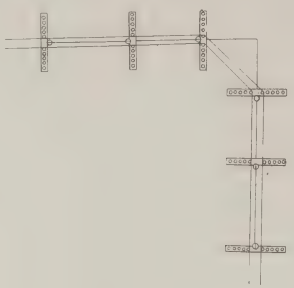

FIG. 27—CORNER GUY.

The strand shall be furnished in coils of not less than 1,000 feet in length.

27. TIE WIRES. Copper tie wires shall be 19 inches long, of soft copper, perfectly annealed.

Iron tie wires shall be 12 inches long, of soft iron, perfectly annealed.

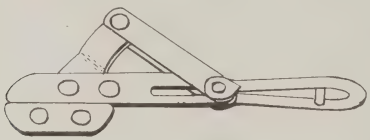

FIG. 28—COPPER WIRE CLAMP.

All tie wire shall be of the same diameter as the line wire to be tied.

28. McINTYRE SLEEVES. Standard McIntyre sleeves shall be used for joining all copper wire.

CONSTRUCTION SPECIFICATIONS.

29. LOCATING LINE. Starting from the initial point, measure off the distance at which poles are to be set

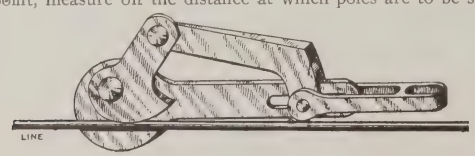

FIG. 29—IRON WIRE CLAMP.

and locate stakes as near to these measurements as possible.

Each stake should have plainly marked upon it the size of pole to be set.

Follow a straight line as much as possible.

30. GRADING. The length of poles set shall be such that abrupt changes in level of the line will be avoided.

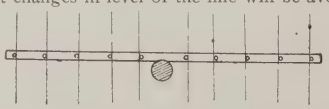

FIG. 30—POSITION OF WIRES ON STRAIGHT LINES.

31. CROSSINGS. At all railroad crossings use poles of a length sufficient to insure a distance of at least 22 feet between the top of the rails and the lowest point to which the lowest wire to be used may sag.

At the crossing of all streets and roads use poles that will insure a distance of at least 20 feet between the ground or road and the lowest point to which the lowest wire to be used may sag.

In crossing the lines of telegraph or other electric companies, use poles that will insure a distance in the clear of at

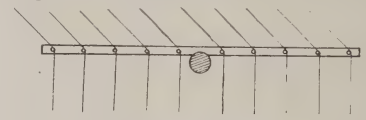

FIG. 31—POSITION OF WIRES ON CURVES.

least four feet between the tops of the poles in the line crossed and the bottom of the lowest gain in the pole used.

32. HAULING AND SELECTING POLES. Poles must be loaded at the yards on wagons in such order that in distributing, the proper length pole can be unloaded at each location in regular sequence.

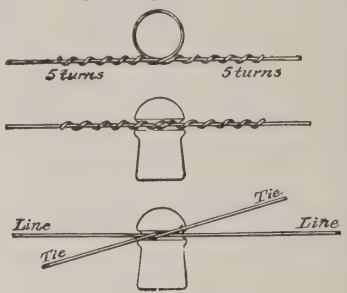

FIG. 32—COPPER WIRE TIE.

The heaviest poles shall be placed on corners and curves and the straightest and best-looking poles shall be placed in cities and towns and in front of residences.

The dimensions of each pole must conform to the dimensions on the marking stake.

33. FRAMING POLES. The roof of the pole shall be formed by sawing the top in a plane at an angle of 45 degrees from the squared top of the pole, and so that the ridge will be in the center and stand at right angles with the crossarms.

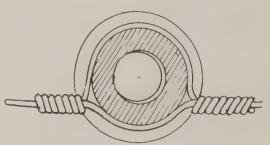

FIG. 33—IRON WIRE TIE.

Each gain shall be cut to the depth of ¾ of an inch, or so as to make a flat surface of 4½ inches and shall be square and true with the axis of the pole and with all other gains and shall be cut so that the crossarm will fit snugly. The center of the top gain shall be 10 inches from the ridge of the pole, and the distance between the centers of the succeeding gains shall be 20 inches. Poles are to be so framed that when set, bends will show least when viewed in the direction of the line. A ⅝ of an inch hole shall be bored through the center of each gain to which a crossarm is to be attached at the time the pole is set. (See Fig. 14.)

All roofs and gains are to be painted with one thick coat of Prince's metallic paint, mixed in the ratio of seven pounds dry paint to one gallon of pure linseed oil.

34. CROSSARMING. All crossarms and braces shall, whenever possible, be attached to poles before the poles are set.

The crossarms shall be fitted with pins and braces before being distributed. Each crossarm shall have its full complement of pins, each pin being driven snugly into place

and fastened in position by driving a six-penny galvanized iron wire nail straight through the shank of the pin.

Each brace shall be attached to the crossarm by a galvanized iron carriage bolt, the head of the bolt and a washer to be on the back of the crossarm and the nut on the face of the crossarm.

The crossarm shall be attached to the pole by a 5/8-inch machine bolt, which shall be driven through the pole from

FIG. 34—COPPER WIRE JOINT.

the back, so that the thread and nut shall be on the face of the crossarm; a square washer shall be placed under the head of the bolt and under the nut. When the crossarm is firmly attached in position the free ends of the braces shall be made to overlap on the pole and attached thereto by a four-inch fetter drive screw firmly driven into position. (See Fig. 14.)

35. STEPPING. Junction poles and poles which are painted shall be stepped with galvanized iron pole steps, driven alternately on each side of the pole in line with the

FIG. 35—IRON WIRE JOINT.

crossarms and staggered 30 inches on centers on each side of the pole extending downward from the crossarm to within ten feet of the ground.

36. LIGHTNING RODS. Every tenth pole shall be equipped with a lightning rod made of No. 9 B. B. galvan-

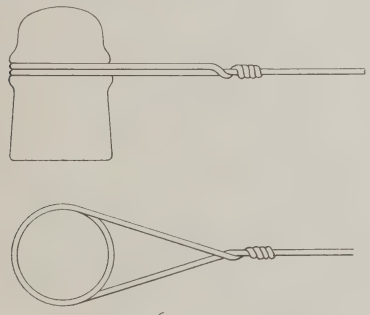

FIG. 36—DEAD END.

ized iron wire, which shall be attached to the pole every two feet by a 1½-inch galvanized iron staple. The rod shall extend to the top of the pole and have two hand turns under the bottom.

37. SETTING POLES. Poles shall be set to depths specified below, except in solid rock, where the depths shall be one foot less, and on curves, where the depth shall be six inches more in each case.

25-foot pole, 4½ feet.
30-foot pole, 5 feet.
35-foot pole, 5½ feet.
40-foot pole, 5½ feet.
45-foot pole, 6 feet.
50-foot pole, 6½ feet.

All holes shall be large enough to admit the pole without hewing or cutting and to permit the free use of the tamping bar around the bottom.

All poles shall be set perpendicularly, with crossarms at right angles with the direction of the line.

The refilled earth shall be thoroughly tamped, three tampers being used for each shoveler. Soil shall be firmly packed around the pole to a height of at least 12 inches above the surface of the ground.

All blasting shall be in charge of men experienced in the use of explosives, and, if possible, shall be let to a contractor who shall be responsible for and assume all risk of damages to persons or property.

Where soft ground is encountered a packing of concrete consisting of one part cement, two parts sand and five parts stone shall be used for refilling. The holes shall be dug from 6 to 12 inches deeper than holes would be dug on curves for poles of corresponding length, and the poles shall rest on a foundation formed of two planks one inch in thickness, 12 inches wide and from 24 to 30 inches long. (See Fig. 15.)

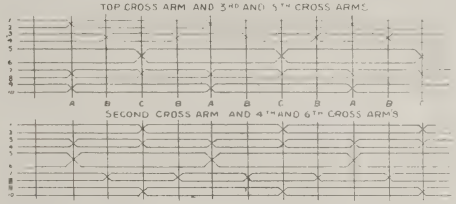

FIG. 37—LOCATION OF TRANSPOSITIONS.

Where quicksand is encountered a barrel shall be driven down, the pole placed within the barrel and the barrel then broken and withdrawn. Small rocks and stones shall then be driven down by tampers in the sand surrounding the pole until no more can be forced downward; rocks shall then be piled about the pole if possible.

All guy stubs shall be set in the ground to a depth of six feet and shall be set so as to lean away from the pole which is guyed to them.

All anchor logs shall be at least ten inches in diameter and five feet long and set to a depth of not less than six feet.

38. FACING CROSSARMS. On straight lines where the distances between the poles are equal, the crossarms shall be placed on alternate sides of the pole, as shown in Fig. 16.

On long spans the crossarms shall be placed on the side of the pole opposite the long section.

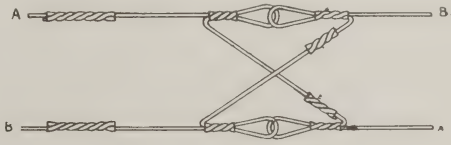

FIG. 38—REGULAR TRANSPOSITION.

At terminals the crossarms on the last two poles shall be placed on the side facing the terminal.

On curves the crossarms shall be placed on the poles, so that the strain of the wires will pull the crossarm against the pole.

At road crossings the crossarms shall be placed on the side of the pole facing the road.

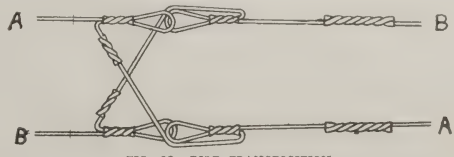

FIG. 39—POLE TRANSPOSITION.

39. GUYING. Poles shall be guyed at every angle in the line greater than ten degrees.

The guy strand shall be 5-16 of an inch galvanized iron guy strand and shall be wrapped twice around the pole or

guy stub and the free end fastened to the long section with a three-bolt clamp. A thimble shall be placed in the eye of the anchor rod and the lower end of the strand passed through it, drawn up tight and the free end fastened to the long section with a three-bolt clamp.

Where the pole to be guyed carries but one crossarm, attach the guy strand above the arm; where the pole carries two and not more than four crossarms, attach the guy strand between the top and second crossarms.

Single guys to anchors shall be used whenever possible and they shall be set in the line of the resultant strain, from the line wires, as shown in Fig. 17.

On lines carrying more than two crossarms head guys, as shown in Fig. 18, shall be used on every twentieth pole.

In a hilly country head guys, as shown in Fig. 19, shall be used.

Poles at the ends of long spans for river crossings and ravines shall be head guyed and side guyed in both directions, if possible.

Where possible the anchor shall be placed 20 or 25 feet from the base of the pole, as shown in Fig. 20. When it is necessary to set the anchor ten feet or less from the base of the pole, the pole shall have a foundation formed of two planks one inch thick by twelve inches wide and thirty inches long, set at right angles, as shown in Fig. 21.

Guy stubs shall be used only where necessary to raise the guy strand to a sufficient height to clear obstacles or traffic and shall be set as shown in Fig. 22.

No guys shall be attached to buildings or trees without special instructions from the superintendent of construction.

At slight curves in the line pole braces may be used, as shown in Fig. 23. The brace shall be beveled off to fit a flattened surface on the pole and attached to it with two six-inch lag screws. The brace shall be set to a depth of at least two feet and shall have a foundation of two planks 30 inches long, set at right angles.

Road crossings may be guyed as shown in Figs. 24 and 25.

Corners may be guyed, as shown in Figs. 17, 26 and 27.

40. STRINGING WIRE. All wire shall be strung from pay-out reels in such a manner that it shall be free from twists and kinks. The grip used in pulling up copper wire shall be of the parallel type, as shown in Fig. 28, and no other kind shall be used.

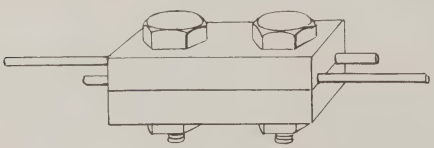

FIG. 40—TEST CONNECTOR.

Iron wire may be pulled up with an eccentric clamp, as shown in Fig. 29.

In stringing wire, the spans shall be drawn up to give a sag, as shown in the following table. Due consideration must be given to the prevailing degree of temperature:

Temperature.	Spans in Feet.				
	100.	130.	150.	165.	200.
Degrees F.	Sag.	Sag.	Sag.	Sag.	Sag.
30	3 inches.	5 inches.	7 inches.	9 inches.	13 inches.
40	3 "	6 "	8 "	10 "	14 "
50	4 "	7 "	9 "	11 "	15 "
60	5 "	8 "	10 "	12 "	16 "
70	6 "	9 "	11 "	13 "	18 "
80	6 "	10 "	12 "	14 "	20 "
90	7 "	11 "	13 "	15 "	21 "
100	8 "	12 "	14 "	16 "	23 "

Long spans, river crossings, etc., when from 400 to 600 feet in length, shall have a sag equal to 1-40 of the span; when from 600 to 1,000 feet, the sag shall be equal to 1-30 of the span.

On straight lines the wire shall be tied to the insulators in the position as shown in Fig. 30.

On curves and corners the wire shall be tied to the side of the insulators away from the strain, as shown in Fig. 31.

41. TYING WIRES. Copper line wires shall be tied to the insulators in the manner shown in Fig. 32. One end of the tie wire shall pass over the line wire and make five

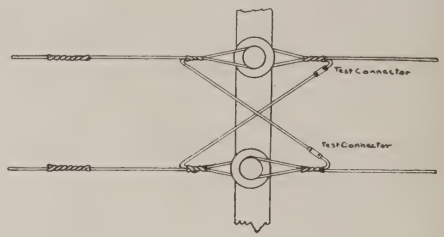

FIG. 41—TRANSPOSITION TEST CONNECTION.

complete turns, and the other end shall pass under the line wire and make five complete turns.

All ties upon iron wire shall be the Western Union tie, as shown in Fig. 33.

42. JOINTS. All copper wire shall be joined with the standard McIntyre sleeve, as shown in Fig. 34. In joining No. 10 B. & S. copper wire, each sleeve shall have three complete turns.

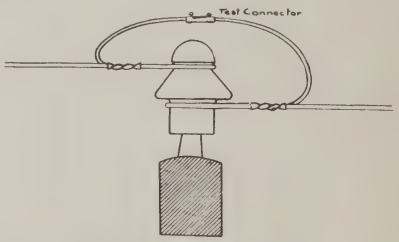

FIG. 42—REGULAR TEST CONNECTION.

All iron wire shall be joined by the Western Union joint, as shown in Fig. 35.

All Western Union joints must be soldered.

43. DEAD ENDING. In terminating a line on any insulator, it shall be given two complete wraps around the insulator and then wrapped four times around the line, as shown in Fig. 36.

44. TRANSPOSITIONS. Transposition poles shall be located as follows:

Measure a distance of 1,300 feet from the first pole of the line and mark the pole nearest to the point so measured "A." Measure successive distances of 1,300 feet each and letter the nearest poles "B," "C," "B," "A," "B,' "C," "B," "A," "B," "C," etc., successively.

The circuits shall be transposed upon the poles so lettered, as shown in Fig. 37.

All transpositions in copper circuits shall be made by cutting the wires on the pole side about 20 inches from the crossarm, and slipping on each a half McIntyre sleeve, with which the wires on the crossarm side are dead ended, one in the lower groove and one in the upper groove of the transposition insulator, leaving the ends projecting. About six feet of slack is then joined to the wires on the crossarm side by using a whole McIntyre sleeve, half sleeves are slipped on and the wires dead ended in the vacant grooves of the transposition insulators. The free ends are now crossed and connected by half sleeves. In dead ending hold the stationary connectors next to the insulator, so that the twists will be made in the long section. All whole sleeves shall be given three complete turns and half sleeves one and

one-half turns. Regular and pole pin transpositions are shown in Figs. 38 and 39, respectively.

Iron wire shall be transposed by dead ending the line upon a transposition insulator and leaving one end long enough to reach the opposite wire and make a half connection thereon. All joints in iron wire transpositions must be soldered.

All crossarms will be fitted up with standard pins. For transpositions cut off the shoulder of the pin and drive it through the crossarm, then drive in the transposition pin and secure it with a nail.

45. TEST CONNECTORS. In order to facilitate testing for and locating trouble, test connectors (see Fig. 40) shall be cut in on all circuits where they pass through towns or railroad stations (provided such towns or railroad stations are at least five miles apart), and at distances approximating five miles throughout the length of the line.

All test connectors shall be located on transposition poles, preferably transposition pole "C."

Fig. 41 shows the method of cutting in test connectors

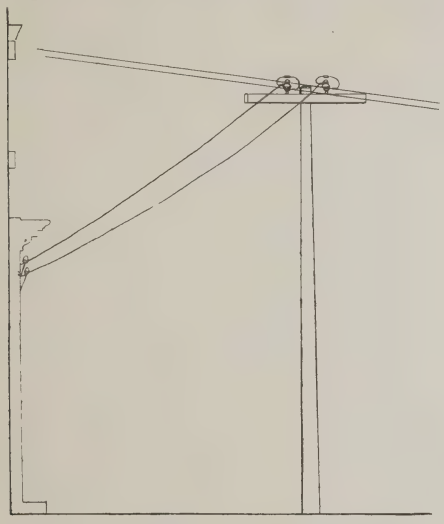

FIG. 43—BRIDGE FOR TOLL STATION.

in circuits which are transposed. Other circuits shall have the test connectors cut in as shown at Fig. 42.

All test connectors must be securely fastened in such a manner that they will in no way cut or injure the line wire.

46. CUTTING IN STATIONS. All toll stations telephones shall be bridged on to the line; this may be accomplished in two ways, by bridging direct, as shown in Fig. 43, or by looping, as shown in Fig. 44. The chief advantage of the latter is that it offers additional facilities for testing.

Open line wire shall be run as close as possible to the toll station telephone, usually to brackets or crossarm fixture attached to the building in which the toll station is located. No. 14 braided rubber insulated copper wires twisted in pairs shall be used from the line wire to the telephone.

The insulated wire must be soldered to the line wire.

In looping in stations, care must be taken not to place a transposition in the line.

47. TREE TRIMMING. All trees shall be trimmed so as to clear the circuits at least 18 inches on all sides, and in such a manner as to cause the least possible injury to the tree or its appearance.

Remove all brush, tree trimmings and debris of every character within twenty-four hours after cutting same.

FARMERS' CIRCUITS.

48. GENERAL. The growing demand for telephone service among those who live in suburban and rural districts, necessitates a method of constructing telephone lines somewhat cheaper than that above described, but which nevertheless will accomplish all that is desired of it, viz., give good and reliable short-line service. The instructions here given are simply methods of modifying and cheapening the standard construction to meet these requirements.

49. POLES. Poles shall be of cedar or good native timber, 25 feet long and not less than 4 inches in diameter at the top. Where more than one circuit is to be erected the poles shall be at least 5 inches in diameter at the top, preferably 5½ or 6 inches.

Poles shall be set in a straight line, not more than 200 feet apart (26 poles to the mile). For crossarm lines 30 or 32 poles to the mile shall be used. It is very important that they be set to the depths specified in paragraph 37, and that the refilled earth be well tamped.

A lightning rod shall be attached to every tenth pole.

50. GUYING. All poles upon which curves or corners are made shall be securely guyed with No. 6 galvanized iron wire. Where the strain is great two pieces of No. 6 wire shall be twisted into a strand and used for guying.

Galvanized iron anchor rods one-half of an inch in diameter and six feet long shall be used.

51. CROSSARMS AND BRACKETS. Where but one circuit is required, brackets shall be used, two of which shall be attached to each pole. The upper bracket shall be placed 8 inches from the top of the pole and the other one 20 inches below it on the opposite side. Each bracket shall be nailed to the pole with one fiftypenny and one twentypenny cut nail.

Where more than one circuit is to be erected six-pin crossarms shall be used. They shall be of yellow pine, 2¾ inches by 3¾ inches, and 6 feet long, bored for 1¼-inch pins. They shall be attached to the pole by two ½-inch by 7-inch lag screws.

Six-pin crossarms shall not be braced except on corners, but the gains in which they are placed shall be 1¼ inches deep.

The pins on a six-pin crossarm correspond to pins 3 to 8, inclusive, on a ten-pin crossarm.

Braces, where required, shall be of galvanized iron 3-16 of an inch thick, 1¼ inches wide and 20 inches long. They shall be attached to the crossarm by carriage bolts, which need not be galvanized, and to the pole with a 4-inch fetter drive screw.

52. INSULATORS. Pony glass insulators shall be used.

53. WIRE. No. 10 E. B. B. iron wire shall be used. It shall conform to the general requirements specified in paragraph 25.

All iron wire joints shall be of the Western Union pattern and must be well soldered.

Transpositions are unnecessary where there is but one circuit on a pole line, but where there are two or more circuits they shall be transposed as directed in paragraph 43.

A single metallic circuit, fifteen or twenty miles long, constructed as above, will give excellent service to as many as twenty subscribers, when connected with bridging telephones.

THE VARLEY DUPLEX MAGNET COMPANY, Phillipsdale, R. I., has issued an elaborate catalogue setting forth the merits of its products. In this catalogue a number of different types of electromagnets and coils are described, included among which are switchboard magnets, ringer magnets, solenoid windings, induction coils, spark coils and many other different styles of coils and magnets. This catalogue should prove of interest to all practical electrical men.

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GREETING.

To every reader of Telephony we extend the season's compliments and wish them full measure of prosperity during the coming year. It seems to be the general consensus of opinion that 1902 will be the greatest telephone year we have ever seen. This opinion seems to be well founded, as each year since the Independent movement began has been very much better in every way than its predecessor. The closing year has been a prosperous one to exchange men, manufacturers, supply houses, pole dealers, and, in fact, all who have in any way been identified with telephone work. For its share of prosperity and success this publication is grateful and extends its sincere thanks and kindest wishes to its readers and its advertisers.

TELEPHONY FOR 1902.

We have decided not to make any specific promises for 1902. It can be depended upon, however, that the present policy of Telephony will be continued. It will cover the art most thoroughly. We have arranged for articles from some of the brightest writers in the field and will add a number of features of unusual interest. In a word, we will give the best telephone journal we can produce, and for our shortcomings will ask our readers' kind indulgence.

TELEPHONY ONE YEAR OLD.

With this issue Telephony will close its first year and its second volume. When the publication was started one year ago we promised it would be conducted on broad lines and would publish telephone articles by the best writers in the world. To show that we have succeeded in this we printed during the year articles by James M. Thomas, Kempster B. Miller, Edward E. Clement, Herbert Laws Webb, Charles C. Cadden, Merlan Chadmer Barry, A. E. Dobbs, E. E. Yaxley, Henry M. Fisk, Stanley A. Duvall, I. J. Kusel, J. C. Kelsey, Frank Goewey Jones, W. D. Dunning, M. I. Pupin, H. C. Dodge, H. P. Clausen, C. F. Bennett, W. A. Taylor, J. G. Ihmsen, J. H. Lendi, C. C. Bulkley, John Paul Bocock, W. E. Doolittle, C. H. Hoffman, George A. Briggs, Henry C. Strong, C. H. Worcester, E. R. Conklin, F. N. Carroll, J. B. Ware, H. S. Coyle, F. F. Sapp, S. P. Sherin, F. S. Livingstone, Chauncey McGovern, Andrews & Murdoch, Thomas J. Fricker, Charles E. Wilson, C. E. Stinson, C. W. Kline, L. W. Stanton, H. D. Critchfield, E. B. Fisher, R. S. Abbott, Charles H. Schweizer, E. H. Andress, D. R. Craig, L. W. Burch, L. C. Walker, G. C. Hamilton, George A. Haywood, J. E. Keelyn, James S. Cuming, Fred De Land, William Lightfoot Visscher, W. A. Foss, James Maret, George Wilkinson, Henry Shafer, A. A. Burch, W. H. Crumb and others. No other publication can show such a list; no other publication could afford it. It is the loyal support of Telephony's subscribers and advertisers which has made it possible to do this. It is this same support which will make it possible to add new names to this list and keep the publication in the lead. During the past year Telephony published more telephone matter and more telephone advertising than all other telephone and electrical journals combined. For all of which there must be some reason.

STORY OF NEW YORK IN JANUARY.

Telephony regrets to say it was unable to gather the data in sufficient time to tell the story of New York in this issue, as promised. This story will appear in our January number, and in February we will publish the telephone story of Pennsylvania. These stories of the states have met with wide favor and will be continued indefinitely.

PURDUE UNIVERSITY TO THE FRONT.

Telephone engineering, embracing all scientific, theoretical and practical phases of this great electrical branch, will be established at Purdue University, Lafayette, Ind., the first of next February. The junior and senior members of the electrical school will devote about one-half of their time to this branch of work. The department will be complete in every detail, since it is almost necessary to finish the education of an electrician of the present age. Upon investigation it was found that in all the large telephonic plants of this country there is an increasing demand for these graduates. When the department is instituted it will be the only one of the kind in the world, and a graduate will be able to set up multiple switchboards and exchanges and design all kinds of apparatus pertaining to the work. The laboratory and lecture rooms for the work will be on the third floor of the electrical building and work has already begun to arrange the rooms. The new department will be under the direction of Prof. J. C. Kelsey, a graduate of the University

of Nebraska, and a man of much practical experience. He is thirty years old and is now with the Duluth Telephone Company and was formerly with the Western Electric Company of Chicago. Mr. Kelsey will be directly under Prof. W. E. Goldsborough, who has charge of the university's engineering department.

The Sterling Electric Company of Lafayette, Ind., deserves a great deal of the credit for this innovation, as the officers of this enterprising company have for the past year pointed out to the faculty of the college the importance of a telephone course. TELEPHONY congratulates the college and the Sterling Company on this advanced step.

THE TELEPHONE.

Wonderful is the ever-ready telephone. The saving which this little instrument effects to the community at large is enormous, estimated either in money valuation or in convenience, or in time, says A. E. Kennelly in the Saturday Evening Post. It is difficult to realize that the large number of telephones now in use in the United States (estimated at nearly three millions) have all come into existence during the past twenty-five years. The electric impulses which actuate the electric telephone receiver, and cause it to emit its vocal sounds, oscillate or reverse in direction at the rate of hundreds of times in a second, in correspondence with the vibrations in the sound waves produced by the distant speaker's voice. Simple as is the mechanism of the ordinary hand telephone receiver, it is yet marvelously sensitive to such oscillatory electric impulses arriving over an electric circuit. The electric impulses are so feeble by comparison with those used in telegraphy that, if it were not for the sensitiveness of this receiver held to the ear, it would be hopeless to obtain practical long-distance telephony. A single incandesecnt electric lamp commonly takes for its operation as much electric current as would supply 100,000 telephones in their ordinary conversational use, and would even be sufficient to supply 20,000,0000 telephones at once, for the production in each of certainly very faint sounds, but yet sounds within the limits of audibility.

The telephone can be made to work successfully over a distance of a thousand miles or more. This, however, has only been accomplished by providing a relatively large conductor, or pair of conductors, so as to offer relatively but little obstruction to the feeble vibratory electric impulses. Beyond a distance of 1,500 miles the vocal sounds become so enfeebled, even with large telephone wires, that conversation is commercially prohibitive. Recently, however, electrical science has come to the assistance of the telephonist in a very interesting way. It has been found that by cutting the telephone wires of a long-distance circuit at every successive mile or so of distance, and connecting into the gap so made a coil of insulated copper wire, the conversational vocal sounds are considerably strengthened at the distance end of the long circuit, thus enabling practical telephony to be carried to a greater distance than would be possible without the use of such extra coils. At first sight this seems a contradictory result, since the operation is equivalent to making the telephone line longer than the actual distance covered, by reason of the many turns of insulated wire included in the added coils. The explanation comes from the fact that the coils of wire become magnetic under the influence of the transmitted vibratory electrical impulses corresponding to the vocal sounds, and the beneficial magnetic influence so obtained more than compensates for the detrimental effects of increased length of the line wire. It is expected that by means of these extra magnetic coils inserted into the lines commercial telephony may be carried on eventually between the extreme limits of the United States and Canada.

As for telephony, we may expect improvements in apparatus, as time goes by, whereby telephonic conversations will be more loudly reproduced, and also carried to greater and greater distances, when desired. The system of telephonic communication should increase and ramify until all buildings, save the smallest, shall be in telephonic communication.

TELEPHONES AND THE PUBLIC.

The relation of any telephone company to the general public is a subject about which much misunderstanding has been common and which is, as yet, perhaps, too little understood by both parties in interest, says the Electrical Review. The very excellence of telephone service has bred captiousness of criticism in the public, which all too often finds expression in complaints for which there is no adequate ground. The fact that one can, through the agency of the telephone, communicate to very great distances and almost instantaneously, is forgotten sometimes when the necessary delay, often of a few seconds, in obtaining connections causes an irascible subscriber to comment on the slowness of the telephone in general and of his local management in particular. As a matter of fact, the speed in telephone exchange service seems to be, in modern exchanges, about as high as it is likely ever to be. With every subscriber that is added to the exchange service the complexity of the whole undertaking is increased and the difficulty of promptly obtaining a through connection is made greater. As exchanges have grown, and often as they have become hampered for lack of room for extension or from outgrowing their switchboard capacity, slight delays in service have arisen, and these, instantly recognized by the public, have called down upon the management extensive blame, when really the fault is in large part due to the users of the telephones themselves. There are just two ways to increase the speed of exchange service, or, in other words, to reduce the time required to obtain an answer from the persons called. One of these is to introduce the best methods and cultivate the highest efficiency in the operation at the exchange itself. The other and more important one is to train subscribers to answer the telephone immediately when the bell rings. Of the delay in obtaining connections perhaps two-thirds may fairly be said to belong to the called subscriber who takes his time about answering his calls.

It is very likely that the future will see a great extension of telephone communication. Indeed, the time is not so far distant when the telephone will become a common and necessary appurtenance of every residence and place of business having any claim to even moderate importance. This state of things will make the telephone exchanges of the future far more complex than they are now, and, unless some new methods which are not at present in sight are devised for handling exchange business, must inevitably lead to somewhat slower work in the exchange itself. This, however, can certainly be more than offset by training subscribers to answer their calls with promptness, thus doing away with one of the most fertile causes for trouble between the central office and its patrons.

The modern exchange switchboard is as nearly automatic as such an instrument can be. The time required to perform the necessary movements for making connections on it has been reduced to the absolute minimum, and the intelligence required has been reduced in the same proportion. The pressure of business necessity has compelled exchange managers to engage a better class of operators to-day than was found in former years. This means more courtesy and better attention to subscribers' wants and greater alertness in giving the desired service. As a whole, telephone service has remarkably improved in the last five years, but there has not been a corresponding improvement in the habits of telephone users, and it is to these that we must look in the future more than to the exchanges themselves for betterments tending to quicken the speed of the telephone's operation.

"Your paper, TELEPHONY, is the best that ever came down the pike. Portsmouth Telephone Co.

TELEPHONE CONSTRUCTION — CITY WORK PLANS.

BY W. H. JOHNSON.

ARTICLE I.

The construction problem, which in the early '80's was hardly more than a matter of fastening a barb wire to such available points of support as might be found along its route, has developed during recent years into quite a complex, serious proposition. The influences that have brought about this change are financially the growth of the telephone business and the rapidity with which it has grown. Less directly, perhaps, but as certainly, the presence of high tension circuits has extended a powerful effect, and finally the requirements which the business makes of itself, in such forms as central energy transmission, battery signaling and the like has added to the necessity for careful consideration of the subject. The four heads seem to cover the aspect of the case broadly and to indicate the general lines of thought to be consulted in an endeavor to turn the experience of the past to future benefit.

In the arrangements of plans it is advisable to keep these points in mind and to provide for the presence or make allowance for the occurrence of conditions that are likely to bring such influences into play. The keynote to the whole situation, briefly put, is the making of proper plans.

This statement at once places before the imagination an array of blue prints, mechanical calculations and the general insignia of the engineer; very necessary in some cases, indispensable in others, but obviously not obtainable in all. A plan may be merely a thoroughly considered scheme, based on careful thought, and it may be profitably preserved for reference, in non-productive investments.

The plans may be started by a general perusal of a good map of the town. It will probably need correcting to some extent and additions, new streets, etc., can be drawn in. Since the prominence of the whole plant depends on the validity of the permission granted to lay ducts, set poles and string wires on public ways, it is essential to know just what authority the permit granting party has in the premises. A short search generally brings the fact to light that some part of a street or alley, considered and used perhaps as public property, is in reality private, and is not subject to general ordinance. It is by no means uncommon to find that a town council, board of aldermen, or such body having authority to make regulations for the use of streets for purposes of traffic, is endowed with no right to grant permits for any other purposes. Under ordinary conditions the town board has the right to grant such permissions as are necessary. Its power, however, to prevent the erection of poles and the placing of wires on them is generally affected by the style of the concern proposing the construction. Incorporation under state laws not infrequently carries with it the right to build pole lines on all public roads, in such a manner as shall not interfere with their use for purposes of traffic.

And while it has been held that on country roads, poles intended for telephone or similar service are a burden not included among the uses for which the land was given by its last private owner, it has also been held that in cities and towns the public welfare necessitates the use of the streets for purposes other than those of traffic, such, for instance, as to contain water and gas pipes, telephone poles, conduits, etc. In plain terms, in such cases as above, the adjoining property holder in the country is the only one who can give a valid permit for any use of the road except that of traffic, while in towns this right is taken from him by the state and is exercised in only a limited way by the town authorities. The right to construct and operate conduits is not given corporations by the legislatures, and so becomes a proper matter for regulation by municipal bodies. In the larger towns where there are several wire using companies to divide the available space above and below ground, the common interests demand a code or rules under which all work can be carried on. The administration of these rules is usually left to a special committee or to a city electrician who is authorized to act for the town government. The question of the restrictions and conditions that a town ordinance may fairly make is very naturally brought up by this line of thought. Such points as the establishment of maximum charges and the payment of a portion of the annual revenue into the city treasury are beyond the scope of this article.

The construction man will be interested in those provisions which specify character of work, minimum height of wires, use of space on poles and in conduits by the city, responsibility for repairs to street and sidewalk paving, and like items. The height of wires above the ground should ordinarily be no greater than is necessary to clear high loads, window shutters, etc. Poles are sold in lengths that increase in five-foot jumps. It is well to adjust ordinance requirements at a figure that will meet this arrangement, when it is known that the contemplated height is close to some figure that it is practical to attain. Thus if the height proposed is twenty-five feet, and it can be changed to twenty-two feet, it will prevent the use of thirty-foot poles, set four and a half feet, and equipped with two crossarms placed respectively six inches and two feet below the top, allowing one foot for dip at the center of the span. Twenty-two feet is to all intent as practical a clearance as twenty-five and the slight concession saves five feet in the height of every pole.

The use of conduit or pole space by the city should be restricted, if possible, to fire alarm, police signal and other low tension circuits. For such purposes any convenient duct may be assigned.

It is customary with many companies to quietly add one duct above their own requirements to each line built, on the assumption that it will be a desirable factor in later transactions. Space for low voltage city wires is usually allotted on the top arm; the end pins if the whole arm is not needed. If it is necessary to provide for high tension conductors in telephone subways, separate manholes should be built along the line for the duct or ducts assigned. The telephone ducts will pass by these manholes and the high tension ducts will pass by the telephone manholes. While the ducts will be donated, it is reasonable to expect that the city will defray the cost of the extra results. A satisfactory arrangement to all interests concerned consists in the city's use of the telephone plant for its low tension service and of electric light companies' ducts and poles for its high voltage wires.

Regarding pavement repairs, though the majority of ordinances stipulate that parties who disturb street surfaces shall be responsible for their maintenance in good condition for a definite period, usually a year, it is really more practical for a conduit owner to stand ready to make reasonable repairs over his subway at any time. This would neither be a desirable nor a fair requirement in an ordinance, but in actual results it makes super-critical inspection during the fixed period of responsibility unnecessary, and at the same time gives the city streets more thorough attention. In other words, a smaller amount expended entirely on necessary work is naturally productive of better results than a larger sum will yield when used lavishly within a very short time.

The selection of a central office location will, of course, depend on the location of the trade to be served.

If a canvass shows that subscribers can be obtained from all sources from which business might naturally be expected, the subscribers' list may be taken as a guide in locating the office. If same class of trade have not responded formally to the canvass the subscribers' list will be a hindrance rather than a help, because, obviously, with good service and courteous business methods, the refractory element will be drawn in anyway. It is evident, then, that an estimate of the number and location of subscribers, and hence

of the proper location for an office, can be more confidently based on the character of the buildings and the needs of the people than on any report of their mental attitudes when first approached. The map may be marked off into districts, each containing the same variety of residence or business buildings, and each district may be marked with a number showing the number of subscribers it ought to yield at once. Another figure in a different color may be placed in each district to show the amount of business it may be expected to afford eventually. The development of a good residence section, due, perhaps, to the extension of a trolley road or the opening of a park, may draw the center of business quite a distance from a point fixed by present conditions solely. The abandonment of an office building district to factory purposes, railroad warehouses and such uses always causes a marked reduction in the number of telephones in the particular vicinity. A quick way in getting at the theoretical center consists in laying off the map into checkerboard-like squares of convenient size, which are each to be marked with the number of subscribers expected at present and in the future. The totals of each kind of figures are obtained. Then a ruler laid crosswise on the map is drawn down it until the sum of the figures (for the present number of subscribers) that it passes over equals half the corresponding total. The central office, to meet present requirements, should be located at the intersection of a line, drawn where the ruler stopped, with a line found in a similar way by drawing the ruler on the map in a direction at right angles to its first position. The same operation based on the other set of figures will give the theoretical location of the office at a time when the prophesied conditions of growth shall have been fulfilled. Either of these centers will have to be corrected to meet practical considerations. Unless the business part of a town is very close to its geographical center, it is quite evident that the location of a central office on the main street is apt to be in error. More commodious quarters at a smaller cost can generally be secured in a less prominent portion of the town.

The backbone or main feed of a system needs to be independent of private caprice and should be built altogether on public property. If the ultimate growth figured on is very much greater than the amount of business that can be counted on at once, it may be best to forego the construction of the main feed, and to build and use as a backbone, for the present, a line which may later become a mere top or local distributing route.

In laying out a system it is well to remember that whatever the terms of the franchise and however liberal the grantors of the first permits may be, subsequent action is sure to take the form of demands for the removal of wires and poles from important public thoroughfares. Unless prospects of considerable business are far off, and unless low original investment is of primary importance, the backbone had best be laid underground at once. If a fair number of subscribers is reasonably certain, it is wise even to stretch the point, relying on the decreased expense for maintenance to offset the interest charge on the greater investment. Since the purpose of the backbone is to reach the distributing lines, the available methods of reaching the consumers may properly be considered next. The cleanest, surest way of delivering service is directly and entirely underground. When the backbone or its branches are underground, this system is generally practicable along a portion of their routes. The next scheme in favor, and one that is more widely applicable, is distribution from poles or a pole set in the rear of the property to be fed in alleys or on back fence lines. Wires so run are less unsightly than they are when strung to building fronts, and all promiscuous street crossing is avoided. The broad rule to observe seems to be to keep the wires on the plant's own property for the greatest possible portion of their length, and to leave the plant for the subscriber's premises in a direct way that shall avoid other private rights and that disturb even the subscriber's own building to as small an extent as may be.

If the town under consideration is laid out with a regular alley system, the backbone should run so as either to intersect as many of the alleys as possible, or its route should be so chosen that branch lines from it will feed these same alleys. If there are no alleys, but if the blocks are open in the centers, the feeding lines, branch or the main, will naturally be arranged to reach the best points of entrance to the blocks. When no sort of internal block system can be made use of, pole lines or separate distributing poles on the streets will have to be erected. In residence sections, in fact, in all but heavy business centers, the street pole line scheme works fairly well. It is the system which gives rise to most objection on the part of citizens and officials, however, and should be avoided, if possible.

When to a reasonable roof rental is added, the expense incurred in roof repairs, in settling claims for weather damage due to trap doors left open, down spouts choked, etc., it will usually be found that a handsome rate of interest has been paid on a sum that might have been invested in poles or other property equipments.

Having decided on the most feasible way of reaching the subscribers, routes for the backbone and for the branches are readily determined. If both or either of them are to be underground, their required capacities must be calculated. The routes selected show the streams in which, so to speak, the business flows to the office. Each time a branch line crosses an alley mouth it picks up an additional group of subscribers, and at each intersection of a branch line with the main feed the contents of the branch is turned into the main.

Using the set of figures which represents the number of subscribers expected ultimately in each block, a system of totals can be compiled which will give the number of conductors which will be needed in each part of the conduit. Since all these quantities are estimates at best, and since it is likely that when the anticipated growth is realized it will hardly be distributed in exact conformity with the plans, it is a good practice to make an allowance which shall provide for some variation. A customary arrangement is to allow a 50 per cent margin in the branches and from 25 per cent in the backbone near the office to 40 per cent at its outer ends. Add to each of the figures placed along the conduit line the percentage of itself, that agrees with the margin decided on. These new figures represent the necessary capacity of the conduit, in pairs. The capacity expressed in cables is obtained by dividing the number of pairs by the number of pairs in the largest sized cables it is planned to use, and allowing a whole duct for any fractional part of a cable left over. Most underground work at present is being based on 200-pair cables, though 240, 300 and 400 pair cables are not uncommon sizes. To the number of ducts so obtained one duct for city use may be added; since companies add another for purposes of maintenance, in lines that are not estimated to need more than two or three; other concerns make it a rule not to lay fewer than four ducts in any one trench, whatever the requirements may figure.

Pole lines are seldom built to carry more than forty or fifty wires. When combination work with high tension wires is necessary the poles must be tall enough to allow a certain amount of dead space between the high and the low voltage arms. The capacity of a pole line beyond the limited number of bare wires it will accommodate is measured by its ability to stand the weight of aerial cables. A line of only a fair grade of construction will support two 100-pair cables, and many cases can be cited of poles loaded with six or eight cables, that weigh from four to six pounds per foot each.

The use of pole lines for such important leads as these instances would indicate, is not recommended. Fires, storms and accidents of several kinds are of too frequent occurrence to make the practice a reliable one.

Wild, extravagant assumptions in making plans are to be carefully guarded against, and on the other side the injunction is to be observed: Don't be afraid of your business.

THE KELLOGG TELEPHONE AND SWITCHBOARD EXHIBIT AT THE PAN-AMERICAN EXPOSITION.

It has been a recognized fact since the opening of the Pan-American Exposition that one of the most attractive and conveniently arranged booths is that of the Kellogg Switchboard and Supply Company in the Electricity building. The display made by this company is very elaborate and its booths, illustrations of which are shown in this issue, will clearly emphasize this statement. What must be still more gratifying to this company is the fact that the supremacy of their apparatus has been attested by the Jury of Awards in assigning to them a gold medal indicative of the highest award on "Telephone Systems and Apparatus."

In order to exhibit to best advantage the systems and apparatus manufactured by this company it was found necessary to provide two booths. The main booth, Section R, contained a general display of its different apparatus, while its branch booth, Section F, is used to display and demonstrate the practical working of subscriber's telephone apparatus.

One of the first things to attract the attention of a visitor upon entering the main booth is a single section of the largest centralized energy multiple switchboard ever built

MAIN BOOTH KELLOGG EXHIBIT PAN-AMERICAN EXPOSITION.

in the world. The ultimate capacity of the complete switchboard is 12,000 subscribers' lines. A board of this type fully equipped would require about forty of these sections. It is provided with line lamp signals and double lamp supervisory signals in the cord circuits. One of the unique features of this board is the simplicity of the spring jacks which are provided with only two terminals and are mounted forty per strip on three-eighths inch centers, thus greatly reducing the area occupied by the multiple jacks on the face of the section and making the cabling so simple as to be easily wired and maintained. The cabinet is of a rich solid mahogany and is provided with a plate-glass panel in the end which enables one to observe the complete arrangement of the multiple cabling. The back of the cabinet is provided with a roller curtain constructed so as to make the board practically dust-proof.

At the front of the open space is a plate-glass display showcase which contains an interesting exhibit of small telephone apparatus used in the construction of switchboards and subscribers' outfits. Several important pieces of this apparatus are shown unassembled.

A duplicate of this showcase in the rear of the 12,000 line board contains a complete line of samples of fine magnet wire, switchboard and telephone cords, and switchboard cable, all of which form a part of this company's product.

Supported on elaborate show boards, conveniently arranged in this space, is shown a complete line of subscribers' wall sets, comprising over thirty-six different types and finishes. These instruments are all connected to switchboards for demonstrating purposes.

A sound-proof booth, located in the rear of this space, contains magneto and centralized battery, subscriber's sets for testing the quality and strength of transmission and comparison of systems.

The section of a 3,000-line centralized battery switchboard, shown in this space, is called by this company a "minor" board, to distinguish it from their "major" board, an example of which is the 12,000-line switchboard described above. This board has several distinctive features besides being provided with full lamp signals. It has all of its operating apparatus conveniently located in the cabinet. This is made possible by the compact construction of the relays. Strips of ten relays are made in a cast-iron case, so as to be mounted on the structural steel frame in the rear of the switchboard. Only one relay is necessary for each line, and there are no contacts to open or close in the talking circuit from the subscriber's instrument to the line jack. Several instruments are connected to this switchboard for demonstrating purposes.

Another switchboard shown in this space which is particularly interesting is a two-division centralized battery lamp signal switchboard. With this type of switchboard the subscriber is provided with two push buttons, which enables him to make direct connection with either division of a two-division multiple switchboard, thus making it possible to connect directly with the subscriber desired without the use of trunk lines. This arrangement is applicable to cases where it is desired to install a switchboard of a greater capacity than it is possible to obtain with a single multiple switchboard. The subscriber's set used in this system is the same as is used in connection with the regular centralized battery switchboard, except that it is provided with a simple double push-button switch. These push buttons, when pressed, change the condition of the line circuit so as to operate a line lamp signal. The first button pushed lights the corresponding lamp by operating its line relay, which stays locked, thus making it impossible for the subscriber to call up the other divisions until the operator at the division first signaled answers and takes down the connection. This method of calling the exchange and interlocking of signals prevents confusion and makes an extremely rapid board.

A combination centralized battery and magneto switchboard is also exhibited in this main floor space. This switchboard is intended for use in small towns where it is desired to give the town subscribers the advantage of the latest designs of telephone apparatus and to make it possible to directly connect magneto lines, such as toll lines and long farmers' lines, with the centralized battery town subscribers. This board has a capacity of 160 centralized battery lines and 30 magneto lines. All of the central office apparatus necessary for operating an exchange of this type, except the battery, is conveniently located in the cabinet of the switchboard. The centralized battery part of the switchboard is provided with line lamp signals and double lamp supervisory signals. The operation of this part of the switchboard is the same as in the most modern lamp signal switchboards. The magneto part of the board is provided with mechanical self-restoring drops and is operated same as the regular drop-type "Express" switchboard. There are two sets of cord circuits—those for interconnecting centralized battery lines and those for interconnecting magneto lines. The centralized battery cord circuits are provided with keys, which make it possible to connect centralized battery lines directly to the magneto lines, while the magneto cord circuits are provided with keys which make it possible to connect magneto lines directly with the centralized battery lines, thus these changes from centralized battery to magneto and vice versa do not require any taking down of the cord circuits after they have once been put up. Several centralized bat-

tery and magneto instruments are connected to the board to show its operation.

A wall type switchboard, which is also shown, has a capacity of 20 magneto lines and is provided with apparatus for four party-line, selective signaling. This particular type of switchboard is largely used for connecting farmers' and toll lines and its construction is nearly as simple as the regular subscriber's wall set, so that it requires no experience to operate it.

Besides the instruments and apparatus described above the main exhibition space contains four "express" type switchboards, ranging from 50 to 200 lines capacity. These

BRANCH BOOTH KELLOGG EXHIBIT PAN-AMERICAN EXPOSITION.

switchboards are provided with mechanically self-restoring drops and a very substantial and convenient arrangement of cord equipment. This type of board represents the simplest forms of telephone exchange equipment for use in small towns where an efficient and rapid means of intercommunication is desired.

At the rear of this main exhibition room just described is an "exchange room," in which is located a centralized battery "Major" switchboard of 3,000 ultimate capacity, with a present equipment of 980 lines. All the apparatus necessary to make this a complete working exchange is located either in this room or in the basement under the booth. A large number of subscriber's instruments of different designs, located in sections F and R, are connected to this board to show its operation.

The line cables enter the basement through regular underground clay conduits and terminate on the main distributing frame in "pot-heads." From these heads a cable made of rubber-covered wire connects the lines directly with "Kellogg" protector strips, which are provided with carbon block lightning arresters and heat rods. These heat rods are used as a protection from sneak currents and are extremely simple in construction and very uniform in operation.

Jumper wire connects the line terminals on the protector side of the main distributing frame to the switchboard side, from which cables are led to the relay rack, containing both the line and cut-off relays. From this rack cables lead to the line side of the intermediate distributing frame and from the switchboard side of this latter frame other cables lead to the answering jacks and lamps on the various sections of the switchboard located in the "exchange room." The multiple cables also lead from this frame and run through the entire length of the switchboard.

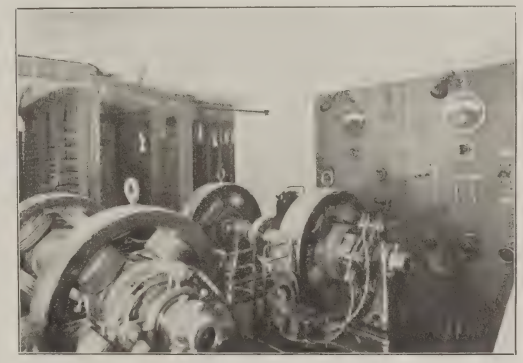
The lead-cased line cables terminating in "pot-heads" each have 102 pairs of paper-insulated wire. The switchboard cables from the main distributing frame to the relay rack have 21 pairs. Those from the relay rack to the intermediate distributing frame are 63 wire, each being formed of 21 pairs and 21 single wires to match. The cables from the intermediate distributing frame to the answering jacks and line lamps have 63 wires each, and those from the intermediate distributing frame to the multiple jacks have 21 pairs each.

All of the switchboard cable is No. 24, B. & S. gauge, tinned and insulated with one wrapping of silk and one of cotton, the cotton covering of each wire being colored in conformity with well-known color codes. After the wires are twisted into cables they are served with a wrapping of heavy manila paper and are then braided and treated with beeswax.

The twisted pair jumper wire used in cross-connecting the line and switchboard side of the main distributing frame is No. 24, B. & S. gauge, tinned and insulated with a heavy wrapping of silk and cotton braid, the whole being saturated with beeswax.

The jumper wire used in connecting the two sides of the intermediate distributing frame is triple twisted, but in other respects it is similar to the wire used in the main frame.

The main distributing frame serves its usual function—that of changing the connection of any line from outside with any line leading to the switchboard, while the inter-



POWER PLANT KELLOGG EXHIBIT PAN-AMERICAN EXPOSITION.

mediate distributing frame is used to change the relation between the answering jack and line signal and the corresponding multiple jack, this latter step being necessary for the adjustment of future arrangement of the number of lines handled by any one operator.

The relays are mounted on iron strips, each of which supports 10 line and 10 cut-off relays. Each relay is protected with a drawn steel shell, which also serves as a dustproof covering. The mounting strips are attached to the relay rack, which is made of iron, affording a fireproof construction, whereby even though a single relay were subjected to a heavy current, which might destroy its winding, it is impossible for it to transmit damage to other relays. Each relay is electrically and magnetically insulated from others on the same strip, and the strips themselves are electrically insulated from the relay rack.

Although all of the apparatus shown in connection with this model exchange is necessarily somewhat cramped for lack of space, yet it is so arranged as to be practical in every way.

The arrangement of the switchboard in the "exchange

room" is the same as that of an operating exchange. There are three sections of three operators' positions each, the two end positions being left blank. This gives each operator 140 lines, each of which terminate in an answering jack with its associated line lamp signal. The answering jacks and lamps are arranged twenty per strip, and are located just above the key shelf in the face of the board. Above the answering jacks and lamps, but separated by white holly strips, are the multiple jacks, arranged twenty per strip, and above these are the spaces for the multiple jacks required by future growth. These latter spaces are fitted with black ebonized panel. The multiple jacks are divided by white holly strips in banks of five strips, thus making 100 jacks for each bank. Each section of the board is divided by vertical style strips into six panels, thus giving two panels for each operator's position. The key shelf contains a complete equipment of 15-cord circuits for each operator. These cord circuits are provided with ringing

ROOF GARDEN KELLOGG EXHIBIT PAN-AMERICAN EXPOSITION.

and listening keys and double lamp supervisory signals, there being one lamp signal for each half of the cord circuit.

The supervisory relays which control the illumination of the supervisory lamps in connection with each half of the cord circuit are mounted in banks of ten on iron strips, fastened directly on the back of the legs of the switchboard section. These relays are so arranged that when a connected subscriber hangs up his receiver the relay will be actuated to cause illumination of the corresponding lamp, but at no other time can the lamp be lighted. This makes it necessary for both lamps of a cord circuit to be lighted before the operator receives sufficient signal to pull down the connections. Each operator's position is provided with a white pilot lamp, which illuminates whenever and as long as any line lamp on this position is illuminated. A red supervisory pilot lamp is also located at each operator's position and illuminates whenever a disconnection is desired. These pilot lamps serve as a check or help to the operators, so that it reduces to a minimum the chances of overlooking a signal of a small line and the supervisory lamps.

A rear view of this switchboard brings out a most striking feature in connection with this "model exchange;" that is, its simplicity and the small amount of cabling used in its construction. This is due to the fact that it is operated on what is known as the two-wire multiple system. The circuits of this board have been so perfected that none of the answering or multiple jacks require more than two contacts, thus the cabling and general construction of all the apparatus is very much simplified over other systems. The frame of this board, as in the 12,000-line "major" switchboard, mentioned above, is constructed of structural steel. The cabinet is of solid mahogany and the opening of the back of the board is closed by roller curtains.

The storage batteries for supplying all direct current for the exchange are installed in a room located in the rear of the basement. This room is provided with ample ventilation and a concrete floor, sloping to a drain. Each battery consists of 10 chloride cells, F-7 elements, 240 ampere hours' capacity, this being sufficient for the present equipment of the exchange. The elements are contained in F-13 tanks, 480 ampere-hour capacity, which are large enough for the ultimate capacity of the exchange. The "discharge leads" from the battery lead directly to the fuse board, located just outside the battery room. From the fuse board wires are lead to the individual cord circuits at each section of the main switchboard.

The power switchboard used for handling all heavy currents required in the exchange, such as the currents for the charging and ringing machines, and the charging and discharging circuits of the storage batteries, is located next to the wall of the storage battery room. It consists of two slate panels mounted on an iron framework. On the first panel is mounted all the switches, starting-boxes and other apparatus necessary for controlling the current delivered to the motor side of the machine. The second panel contains all of the switches, underload and overload circuit breakers, ammeter, shunts and rheostats for controlling the generator current in charging the storage batteries. At the top of these slabs are mounted a flush round pattern Weston ammeter and a voltmeter and switches for connecting them to any of the direct current circuits terminating in the power switchboard.

A duplicate set of charging and ringing machines are used in connection with this exchange as an extra precaution against breakdown or the failure of current supplied from an outside source. The machines are of the Holtzer-Cabot type and of the following sizes: The two generators provided for charging the storage batteries from 110 volts, direct current, are Holtzer-Cabot type, H. P. D., 1,850 watts output. There are two ringing machines, Holtzer-Cabot, type B, one-quarter horsepower; one runs from 110 volts direct and the other from 10 cells of storage battery. These ringing machines deliver 75 volts alternating and pulsating current from their secondary windings.

The power apparatus is mounted on power tables, constructed of masonry, besides being covered with white tile brick and top surmounted by a heavy slate slab. All slate used in both power boards and tables was obtained from the famous Monson (Maine) quarries, and is especially adapted for this purpose.

All of the power wiring in this "model exchange" is of the most substantial character and is protected by being drawn into "Richmondt" steel conduits.

The roof garden, located over the "exchange room," of the main exhibit, is reached by a flight of winding stairs similar to those commonly used in telephone exchanges. Suspended over this roof garden from the girders of electrical building is an elaborate double-faced electric sign, nearly 22 feet long and about 7 feet high, built by the A. & W. Electric Sign Company, Cleveland, Ohio. Each letter of this sign is connected to a "flasher" located in the basement of the booth, so that the word "Kellogg" can be flashed in any combination.

In order to demonstrate the operation of the Kellogg systems, and especially the transmission and receiving qualities of their subscriber's instruments, it was found necessary to isolate a part of their exhibit so as to give more nearly the actual condition of the subscriber with relation

to the exchange. Thus the branch booth in section F was designed solely for this purpose. This space is provided with two sound-proof telephone booths, same as used for long-distance transmission work. These booths are both supplied with centralized battery and magneto subscribers' instruments, which are connected by artificial lines to the switchboards located in the main exhibit, section R.

The architectural design and arrangements of these booths is well balanced, and with the extensive exhibit go to make up one of the largest and most interesting collections of telephone apparatus ever shown to the public.

The Kellogg Switchboard and Supply Company industry is one of the largest in Chicago. The factory has a capacity of turning out 2,000 telephones a week. It has 89,000 square feet of floor space and employs nearly 1,000 men. The company has one of the largest and most perfectly equipped experimental laboratories for expert study, testing and experimenting in the world. The engineers employed are the leading men in their profession, and are graduates from the best colleges in this country or abroad, and all of them have had a broad and varied experience in electricity and telephony.

A PROMINENT TELEPHONE ENGINEER AND INVENTOR.

Among the many engineers and inventors who have come into prominence since the opening of the Independent telephone business, might be mentioned W. E. McCormick of Chicago, a brief account of whose work in telephony may be of interest at this time.

Mr. McCormick started in the electrical field in 1885 with the Western Union Telegraph Company, as messenger in the Chicago Board of Trade. From there, after holding several positions, he went with the Chicago Telephone Company early in 1892, as a helper in the underground department. Here, by his close attention to his work, he soon showed his natural energies and capabilities, and in less than a year was promoted to the position of assistant foreman of that department. In the winter of 1892 and 1893, when the installation of the model Bell telephone plant for the World's Fair was started, he was given full charge of the cable work, and supervised this work during the fair and until the plant was removed. He then took up the work with the company in the line construction department, and later in the instrument department. After becoming familiar with the work in these lines, he secured a position in the engineering department, where he started work on the switchboard of the first express telephone system installed. In this work he soon showed his inventive genius, and was given the handling of the practical experimental work of the engineering department on the common battery system. When this system was sufficiently developed, he took charge of installing the first successful common battery telephone plant in the United States. He later had charge of the installation of the lamp signal, relay multiple common battery system switchboard of the company's new Oakland office, then probably the finest and most modernly equipped telephone office in the country; while at this work he personally supervised the conducting of the practical experiments of the company, on a system with lamp signals placed directly on the line. While at the work of changing the Oakland office plant from the system with lamp signals direct on the line, as was first installed, to the relay lamp system, he invented a transfer circuit for the latter system, which was adopted for the entire exchange. Among the most important inventions he made while with this company was the common lamp visual signal switchboard, the patent on which he at that time sold to the American Bell Telephone Company. One of his inventions while there (which he did not cover by patent) is the perforated back transmitter mouthpiece, now being largely used in the Independent field, as well as by the Bell company. He was on the engineers' staff when he resigned his position early in 1897, to take a position with the Stromberg-Carlson Telephone Manufacturing Company, as superintendent of the switchboard department. In June, 1899, he resigned from this company and took a position with the reorganized Western Telephone Construction Company as its general superintendent. Through his energy and hard work he devised that company's common battery multiple switchboard, prepared all the special tools necessary for its manufacture, and built a six hundred line equipment within the first six months of his connection with the company. Among his inventions while there (besides their multiple switchboard and common battery system) was the perforated telephone receiver cap.

June 1 last he resigned his position, and began experimenting on different lines of improvements on all classes of telephone apparatus, and made up samples of each kind of instrument and parts, and has devised what is claimed to be one of the most neatly designed and durably constructed and efficient lines of apparatus yet produced. On his regular generator call telephone he has not only quite a different and improved form of transmitter and receiver, but he has a number of new features on each one of the other parts of a telephone, such as improved parts on the ringer, generator, switch, transmitter-arm, and lightning arrester. Patents have been allowed, it is claimed, on practically all of the improvements and new features on each of these parts. He also devised a new self-restoring drop switchboard for the regular generator call system, on which we are informed twenty-six patent claims have been allowed.

Besides the many new features on generator call apparatus, he has devised a new circuit for a full central energy system, and a complete lamp line signal multiple switchboard, which is said to be more simple than any other in use.

For manufacturing and putting on the market this full line of apparatus, which he has designed during the past six months, the International Telephone Manufacturing Company has been organized, of which he is the vice-president, and will have personal supervision of the manufacture of its product.

From Mr. McCormick's wide experience in telephone work in the constructing and operating field, as well as in the manufacturing line, much may be expected of the new company.

THE TELEPHONE.

"I want to talk to Clover Bloom,"
Said Buttercup one day.
"I wish there was a telephone;
She lives so far away, heigh-ho!
I have so much to say."

Now Mr. Spider heard her speak
As he was passing by.
"I'll build for you a telephone,
"At least, I'd like to try, he he!
A builder fine am I."

So then he climbed the ladder stem
And then he spun a thread
Above the Daisies—how they stared!
Above the Grass's head, hi, hi
To Clover's home it led.

A silken wire telephone;
Now Buttercup is gay,
For she can talk to Clover Bloom
The livelong summer day, ha ha!
I can't tell what they say.

—Abbie Farwell Brown, in Interior.

"I am well pleased with paper and think every telephone man should read it.

M. L. ROBESON, Mgr.,
Galena, Kan."

WELL-KNOWN HEADS OF WELL-KNOWN HOUSES.

A BIOGRAPHICAL SKETCH OF CHARLES W. FARR.

Few men are better and more favorably known in the telephone business than Charles W. Farr, president of the Farr Telephone & Construction Supply Company of Chicago, whose portrait is presented herewith. Mr. Farr was born in Port Huron, Mich., in 1849, and early in life took a fancy to telegraphy and telephony. At the age of twenty-two he became connected with the Western Union Telegraph Company, serving for fourteen years under District Superintendent E. P. Wright. It might be mentioned that for the entire fourteen years Mr. Farr did not miss a single day. He was the local manager of the company for fourteen years. The three years following he served under I. McMichael, district superintendent of Minneapolis, Minn. He

CHARLES W. FARR.

then became local manager of the Michigan Bell Telephone Company, with headquarters at Detroit. During his last year with the Bell Company he served mostly as state inspector, examining most of the exchanges and making himself thoroughly familiar with every phase of telephony. He then came to Chicago, and in February, 1895, formed the Farr Telephone & Construction Supply Company. The principles which Mr. Farr and his associates have always followed have given the firm an honorable name, and as a consequence the company has and is receiving orders from all over the world. The Farr Company manufactures everything in the telephone line—from the smallest part to complete exchanges—and the excellence of its products has given it an enviable reputation. Mr. Farr is an unassuming, quiet gentleman and is highly esteemed by all who know him. His untiring efforts have placed the Farr Company where it is to-day, and the concern is to be congratulated on having so energetic a man at its head.

BRITISH TELEPHONE NEWS.

(From our London Correspondent.)

The publication of the long expected rates of subscription to the government telephone system in London has raised a storm of protest from everyone except the National Company, by reason of the fact that to all intents and purposes one gets no material advantage in becoming a subscriber to the government. At present the company's rates are £20 per annum for unlimited service on a one year's agreement, and £17 per annum on a five years' agreement, whilst no message or toll system is in vogue. For a second connection a subscriber has to pay £10 per annum. On the other hand, the postmaster-general only works on one-year agreements and charges £17, and for a second connection £14. He has also introduced a message system for small users of the telephone, and also a party line message rate service for two to ten subscribers at varying rates, but no party line connection will be made in the central part of the London area, i. e., to the central exchange. After the example set by Glasgow and Tunbridge Wells, Londoners are grievously disappointed at this treatment and feeling in the matter is being shown in no half-hearted fashion by the newspapers, irrespective of their political policy, and, inasmuch as in the postoffice circular announcing these terms we are told that postoffice subscribers will have the right to communicate with those of the National Company in the London exchange area at the same rates of charge as for communication with other postoffice subscribers, we are asking ourselves, after a careful analysis of the proposed message rate system, what kind of competition it is that the government is launching against the company. Originally something about a £10 rate was suggested, and at the present time Glasgow is charging £5 for unlimited service; hence the trouble brought upon the heads of the government, in which the London county council is taking a leading part, and, from their point of view, a good deal has been published. This latter body has all along been anxious, as the government of London, to undertake the telephone service themselves, but were prevented by Parliament, and their views on the matter are well seen in their offer to pay the postoffice all that their system has cost up to date and take it over and maintain it on a cheaper tariff than the above.

But since the public were informed of the subscription rates certain facts have been published as to agreements with the National Telephone Company, which puts the government in a still more unfavorable light, in fact, from a business point of view, one might almost say a ridiculous position. The main contract entered into between the postmaster-general and the company, besides fixing the rates, which will be charged equally by the two parties, and other things, provides for the purchase of the company's plant in London at the expiration of its license in 1911. It also contains provisions under which the company will be able to obtain the use of underground wires in London upon reasonable terms. The company itself states that the real and underlying principle of the agreement seems to be that for the future there is to be mutual co-operation between the postoffice and themselves in the development of the telephone system in London. In other words, it will be "competition," as regards quality of service, and "co-operation" as regards working arrangements. But in our own interests, and as an echo of the complaint of the London county council, what need is there to buy the company's system at all? The company's license expires in 1911, and they cannot carry on business after that date, and, further, they can compel no one to buy their plant. The purchase price is to be its fair market value at the time of purchase, and it is for this that London is denied the advantages of true municipal trading, as exemplified at Glasgow. One hears the question asked as to why the postoffice wishes to buy a duplicate system in this way, when they have only just been to the trouble of turning up the streets to install an admittedly more perfect one of

their own, and one also hears in response whispers of Parliamentary influence.

Whether the rates will be revised there is no sign to guide us, but, looking at the matter from a common-sense point, it is difficult to conceive that it was thought possible for these arrangements to meet with any degree of approval. Indeed, they prove curious reading in contrast to the evidence before the select committee of the Houses of Parliament prior to the passing of the 1899 act.

An interesting side light on the controversy is to be found in the inaugural address to the Society of Arts by Sir William Preece, late engineer-in-chief to the postoffice, an address written before the publication of the offensive subscription rates. Sir William remarked that twenty-four years had passed since he brought the first pair of telephones to England, and it would now have been everywhere but for mismanagement. The government had never firmly faced the situation. At that time unlimited licenses had been issued and companies sprang up like mushrooms, and these were, by the usual commercial means, consolidated into one large company, the National. The telephone service of the country was a monopoly in the hands of private enterprise, without statutory rights, which was not popular. The postoffice had not been allowed to compete until Parliament interfered, and the result was now confusion worse confounded. The real and only solution had not yet been taken up. A cheap, efficient and reliable telephone service was imperial, and, like letters, parcels and telegraphs, should be solely in the hands of the government.

But it is a fact that the telegraph system is worked at a loss, and it has been hinted that by playing into the hands of the National Telephone Company in the manner in which it undoubtedly has, the postoffice hopes to pay off some of this deficiency. As usual, in the midst of this outburst of feeling, we are treated with the inevitable official stoicism under such circumstances, and the general tendency would appear to be to boycott the system until a satisfactory explanation is given, which does not seem possible. Unless our bark is stronger than our bite, the government will find it greatly to its advantage to cater for the British public and not for the National Company, seeing that, in the words of a postoffice official, competition with the latter was undertaken as the result of public pressure.

It is one thing to pass an act of Parliament and quite another to manipulate its intricacies when endeavoring to pilot the particular measure to a satisfactory issue. At Portsmouth quite recently a great deal of diversity of opinion manifested itself during an inquiry into an application on the part of the local authority to borrow £26,000 for equipping a municipal telephone exchange. In the early stages of the proposition Mr. A. R. Bennett, the present consulting engineer, quoted £19-10-0 per subscriber as sufficient capital expenditure, whilst Sir W. H. Preece, reporting upon this estimate, replied that such an estimate could only be for something cheap and nasty. His figure was £35 per subscriber. However, the municipality decided to retain Mr. Bennett, and, in the face of an opposing petition signed by nearly 15,000 ratepayers, an inquiry was held, but the result is not yet known. The proposed subscription is £5-17-6 for unlimited service and £3, with a toll of ½d per call, or £2-10-0, with a toll of 1d per call, another refutation of the postoffice extortion in London.

The proposed combination between Manchester and the surrounding urban districts has now assumed material form. A bill has been lodged and the area over which powers are sought to maintain a competitive telephone service includes the city of Manchester (itself sufficiently comprehensive) and twenty-seven county and urban district councils.

At this period in each year it is customary to review the work of the previous twelvemonth. So far, contrary to what the general public had been led to expect, although municipal competition with the National Company is slowly but firmly establishing itself, the latter has really strengthened its hand. What the company has lost in Glasgow, if it has lost anything at all, has been amply counterbalanced by the almost masterly stroke of diplomacy underlying the agreements with the postoffice in London. They have also equipped another splendid exchange in the west end on the central battery system, and, despite the £150,000 and more paid to the postoffice during the year as royalties, the tone of the directors' reports is the very reverse of despondent. As to municipal competition in the provinces, probably the real effect will be noticeable during 1902, as a large number of services now in process of equipment should be put into use. It is noticeable that the estimates of the various consulting engineers are based upon subscription rates considerably cheaper than those prevailing under the National Company, the average being between £5 and £6 per annum for unlimited service.

PERSONALS.

MR. JAMES S. HEALY has been appointed manager of the Corning (N. Y.) exchange of the Century Telephone Construction Company.

MR. FRED E. FREERS, general superintendent of the United States Electric Company of Butler, Pa., was a recent Chicago visitor. Mr. Freers is on a business trip through the western country.

MR. J. N. BROWNLEE of the Brownlee Lumber Company, Meridian, Miss., advises that the company has been obliged to build another addition to its factory to properly handle its largely increasing business.

MR. JAMES E. HOLYOKE, well known in telephone circles in the West, is now connected with the Columbia Telephone Manufacturing Company of Chicago in the capacity of superintendent of construction.

MR. GORDON L. FOWLER, general sales agent of the United States Electric Company of Butler, Pa., was married to Miss Bessie K. Lockwood of Terre Haute, Ind., on December 18, 1901. The young people will live in Butler. TELEPHONY extends its sincere congratulations.

MR. EDWARD W. JEWELL, who was formerly president of the McIntosh Battery & Optical Company, has retired from that company and will in future devote his entire time and energy to pushing the business of the Jewell Electrical Instrument Company. Mr. George M. Wills, formerly connected with the latter company, has retired from it to enter other business.

MR. JAMES H. PARISH, formerly with the Western Telephone Construction Company, Chicago, has accepted the position of secretary and general manager of the Standard Telephone & Electric Company, Madison, Wis. Mr. Parish is one of the pioneers in the Independent field and is well known in telephone circles. He was one of the organizers of the old Detroit Telephone Company and the Kinlock Telephone Company of St. Louis, assisting materially in the construction of both systems. He was also with the Kellogg Switchboard & Supply Company. Mr. Parish has made many friends. He is able, courteous and aggressive, and the Standard Company is to be congratulated on securing so valuable a man.

An old man from the country would not believe that he could hear his wife talk a distance of fifteen miles by telephone. His wife went to a neighboring city one day and the old man went to satisfy himself by experiment with the telephone. He went to the telephone exchange office and told them he wanted to talk to his wife. They explained how to operate the 'phone and the old gentleman walked boldly up and exclaimed "Hello, Jane." At that instant lightning struck the telephone wire and knocked the old gentleman down, and as he scrambled to his feet excitedly cried, "That's Jane, by gosh!"

TRADE NOTES.

THE CALUMET TIRE RUBBER COMPANY desire to quote prices and submit samples of anything in the company's line.

THE WARNER ELECTRIC COMPANY, Muncie, Ind., is now ready to furnish its battery switchboard power generator, fitted for pulsating current for selective signaling.

THE WILLIAMS ELECTRIC COMPANY, Cleveland Ohio, is sending out a little leaflet, entitled "Something New." It contains one illustration and is printed in colors.

THE ST. LOUIS ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., is placing on the market an electric wire clamp in varying sizes, manufactured under the Fletcher patents.

MR. R. H. LEAVITT, Capron, Ill., manufacturer of pins, brackets and cross arms will be pleased to quote lowest manufacturer's prices on his product and invites correspondence from prospective purchasers.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is advertising its special five-magnet generator number thirty-six telephone for heavily loaded or poorly constructed farmers' lines. The company claims this generator will ring through anything.

THE EUREKA ELECTRIC COMPANY, Chicago, will mail, upon request, a card it has just issued, calling attention to its line of heavy enameled iron signs, ground transparent glass signs and electrotypes of same for letterheads, the latter of which are furnished without charge.

FARR & FARR, Chicago, are much pleased with the demand for the line of "accommodation telephones" which they have been advertising of late. They are shipping these sets, which are sold at attractive prices, to all sections of the country, and they report that they have yet to get the first complaint.

MESSRS. W. H. ANDERSON & SONS, Detroit, manufacturers of telephone construction tools, cross arm braces, pole steps and railroad construction tools, have appointed James P. O'Donnell, 36 La Salle street, Chicago, as their western representative. Mr. O'Donnell is well acquainted with the trade in Chicago and the Northwest.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, Chicago, reports a great demand for its telephones. As fast as the apparatus is finished it is packed and turned over to the railways, which are taking it to every part of the United States. The company has been obliged to put on a night shift of workmen in order to fill its orders.

THE CHICAGO TELEPHONE SUPPLY COMPANY, Chicago, reports the sale of six express type switchboards to one large company in Costa Rica, to replace Bell apparatus. It is said this purchase was made after a careful inspection of the various types of switchboards on the market. The progressive policy of the Chicago factory is rapidly building up an export business of considerable magnitude.

THE AMERICAN BATTERY COMPANY of Chicago has issued an elaborate price list of its American storage cells, which received the highest award at the World's Columbian Exposition in Chicago. It contains also description of the construction of the different parts of the cells. The same company has issued a price list of the American portable storage cells. It contains an elaborate description of these cells.

THE AMERICAN TOLL TELEPHONE COMPANY, 43 to 47 Sheriff street, Cleveland, Ohio, is the manufacturer of high-grade automatic pay stations. This company's machines have met with much success and are sent on thirty days' trial if requested. They are supplied in all sizes and run from single coin to several denominations of our coins. The company also manufactures a call register designed to keep a record of outgoing calls, which can be attached to any telephone.

THE ELECTRIC STORAGE BATTERY COMPANY of Philadelphia has under construction several batteries for United States government service, two of them being for Fort Washington, Md., and one for Fort Hunt at Sheridan Point, Va.

J. H. BUNNELL & CO. of New York have issued a very elaborate and complete catalogue and price list of their electrical supplies. In it their electric railway appliances, telegraph, telephone and electric light supplies are described. This catalogue should be of great service to those who are contemplating the purchase of such apparatus. The same company have also issued a neat pamphlet describing their telephones and accessories.

THE WILLIAMS-ABBOTT ELECTRIC COMPANY has opened an office for the introduction, exhibition and sale of its new and complete line of telephones, switchboards and appliances at 1005 Monadnock block, Chicago, under the management of Mr. H. C. Dodge. Correspondence is invited from the trade generally and a call from buyers and friends. Chicago display sheet "B," with accompanying price list, will be mailed upon application.

THE WESTERN ELECTRICAL SUPPLY COMPANY of St. Louis reports that its demand for line and construction material has been heavier this fall than at any previous time in its business, and states that it is carrying a very large stock of this material, and is prepared to ship promptly any of the many appliances necessary to fix up lines for the heavy winter strain on them. A very complete catalogue covering these supplies is issued by the company.

GARTON-DANIELS COMPANY, Keokuk, Ia., reports a constantly increasing demand for its extension circuit device. It has placed on the market a new model of its ringer, and, as an evidence of interest in taking care of its customers, is offering to replace any of the old models which are not proving satisfactory in continued service. A new pamphlet is being issued by the company, fully illustrating and describing its apparatus, which will be sent postpaid upon request.

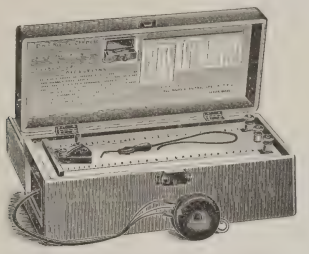
THE STANDARD TELEPHONE & ELECTRIC COMPANY, Madison, Wis., is now settled in its new factory, entirely rebuilt since the recent fire. In the new buildings, which are of nearly twice the capacity of the former shops, departments have been rearranged in such a way as to enable a volume of business more than double that formerly done to be handled. The company is about to put upon the market multiple and central energy apparatus and already has advance orders for a number of exchanges.

THE MANUFACTURERS' ADVERTISING BUREAU, of which Mr. Benjamin R. Western is the originator and proprietor, gives evidence of its prosperity by extending its accommodations at its old-time location, 126 Liberty street, New York. The new offices have greatly increased facilities which have become necessary by the growth of the bureau's business since its establishment in 1877. The Manufacturers' Advertising Bureau is the representative of many of the leading manufacturing concerns of this country, as well as Europe, some of which have been its clients for twenty years.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY, Chicago, has just issued Bulletin No. 6, which fully explains how to construct rural telephone lines. The advantages and reasons why the farmer should have a telephone are given, as well as a great deal of practical information on telephone line construction, estimates of cost, etc. The booklet is profusely illustrated and will be sent upon request to those who mention TELEPHONY. The company will also send Bulletin No. 4, explaining small switchboards for central battery, and Bulletin No. 5, which illustrates and describes Kellogg transmitters and receivers.

A NEW ELECTRICAL MEASURING INSTRUMENT.

As a portable testing set for obtaining the resistance in telephone and other electric lines, and for locating trouble, the direct reading ohmmeter is regarded as one of the most convenient, reliable and inexpensive instruments of its kind. The Illinois direct reading ohmmeter, illustrated herewith, put on the market by the Illinois Electrical Specialty Company, at 1203 Marquette building, Chicago, Ill., is a decided departure from the electrical measuring instruments that have been used in the past. This instrument, which was fully patented only July 24 last, is said to have a large demand, a number of them having been in use for some time with good results. In this instrument three sides of a quadrilateral circuit are adapted to be energized from the sources of current. The fourth side of the quadrilateral is the conductor, of which the resistance is to be determined. A telephone watch case receiver is included in one side of



ILLINOIS DIRECT READING OHMMETER.

the quadrilateral. There is a conductor, which is used in connection with the remaining two of the three permanently provided sides of the quadrilateral, and in shunt with the receiver and the conductor of which the resistance is to be obtained.

The instrument is provided with binding posts, to which the lines may be connected in which it is desired to determine the resistance.

It is also provided with a battery switch and a pair of small dry batteries. To one of the line posts is attached the stylus or finger, with a metal tip, connected by a conducting cord to one side of the line when tests are made. On the face of the case, when open, is placed a dial containing the scale of resistance.

In making a test the lines to be measured are connected with the two-line binding posts. The battery switch is then closed, and the receiver is placed to the ear to ascertain to which binding post the point of silence is nearest. The stylus is touched lightly on first one of the posts and then the other, and the one where the click is the faintest, the point of the resistance is the nearest. Then the stylus is touched lightly over the scale until a point of absolute silence is reached. The figure on the scale directly underneath this point indicates the resistance in ohms of the lines indicated. Then by referring to a table of resistance the length of the circuit can be ascertained.

Lines can be measured from any part of an ohm to 200,000 ohms. To locate a short circuit on a metallic line, assuming that the instrument gave a reading of 96 ohms in testing No. 12 iron metallic circuit, in which the wire has a resistance of 32 ohms per mile and the two wires give a total resistance of 64 ohms per mile, an indication of 96 ohms on the scale would show that the trouble was at a point equal to 1½ miles from the point of testing. In this way any telephone exchange trouble can be located accurately from the central office, or from any exchange where the morning test is regularly made, in case the subscriber does not answer the test call. A test with the ohmmeter will ascertain the condition of the line and ringer coils, and if the proper reading of the line is given, it will show clearly that there is no trouble in the line or instrument. In this way cables and instruments of various kinds can be tested, as well as open wire circuits.

Defective connections in telephone instruments can be detected by connecting the ohmmeter to the line posts. Take the telephone receiver from the hook and rigidly attach the binding post and connection, including the receiver cord, and if a defective connection is disturbed a scraping noise will be heard in the receiver of the ohmmeter. In this manner listening and ringing cams on switchboard and other parts can also be tested, and defects located. Telephone transmitters can be tested by disconnecting the telephone batteries and connecting the ohmmeter with the battery wires, and by tapping on the transmitter its sensitiveness can be determined by the ohmmeter receiver; then the resistance can be compared by a transmitter of the same make.

The instrument does not need to be placed upon a level surface, and it has no independent resistance coils, plugs, galvanometer or other complicated mechanism. The strength of the battery in no way affects the accuracy of the instrument, and the latter can be as conveniently used on a pole out on the line as at the central office.

Inside the top of the cover is placed a complete list of instructions and a table showing the resistance in ohms per mile; the resistance in ohms per thousand feet, and the diameter of copper wire ranging from O. V. & S. G. to No. 36. Also a table of the resistance in ohms per mile, and the resistance per thousand feet of E. B. B. & B. B. iron wire, and steel wire ranging from No. 5 to No. 18.

The instrument is inclosed in a neat polished hardwood case about 14 inches long, 6 inches wide and 5 inches high, weighing about five pounds. The case is provided with a strong lock and key for securely fastening the cover, and on top of the cover is fastened a neat leather handle.

"HELLO" GIRL IS HUMAN.

The witty Roswell Field, who is occasionally almost as amusing as his lamented brother, Eugene, has recently said in one of his Boston letters that the telephone girl of this modern Athens is the past grand mistress of pertness and sauciness—and of dilatoriness to boot. After which sweeping indictment he proceeds to set forth in a fairly moderate fashion the causes which lead to this sate in the mind.

"Deliberation, so common in other branches of the public service, is not tolerated," he says, "in a telephonic communication; therefore, the telephone girl is always in a hurry. This haste, so antagonistic to the traditions of a town like Boston, naturally gets on the girl's nerves; from a placid, even-tempered, well-spoken young woman, she is transformed into a nervous, irritable, impatient creature, and frequent explosions are the inevitable result.

"To me," he concludes, "all this appears to demonstrate that the Massachusetts sister is merely human, like the rest of us."

AN AFFIDAVIT BY TELEPHONE.

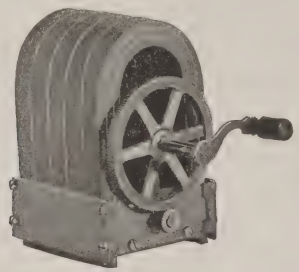
A new dignity and added importance are given to the telephone through a recent decision by Judge Burke of the Circuit Court of Baltimore, sustaining the legality of an affidavit thus made and taken "over the wire." Osborne I. Yellott was some time ago appointed receiver of the Mauer Lumber Company, whose business is in Baltimore County. Subsequently officers of the corporation petitioned the court to have the appointment set aside on the ground of alleged illegal proceedings incident to the preliminary steps in the case, as follows: When Mr. Yellott was ready to file the necessary papers, asking for a receiver, he had Mr. Cross come to the long-distance telephone at Cincinnati, and Justice Thomas Butler, who knows Mr. Cross very well, took his affidavit to the bill.

It had previously been held by the courts that affidavits could not be taken in such manner under the law—also that oaths so administered or testimony so taken is invalid in law. Judge Burke held that Justice Butler's ability to recognize the voice of Cross was quite as sufficient as his presence in person.

1902 APPARATUS.

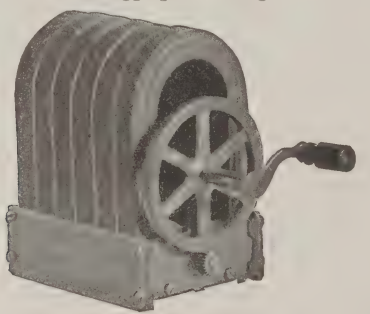
Two new generators are among the features which will characterize Chicago telephones for 1902.

The new Chicago bridging generator No. 1 has, it is claimed, a larger quantity of magnet steel than any other bridging generator. The best and highest priced magnet steel is used, and, when treated by the "Chicago method," the most satisfactory results are obtained. Lamination in its truest sense is employed. A compound magnet is more powerful than a single one. That is, a magnet made up of



CHICAGO BRIDGING GENERATOR NO. 1.

many similar parts is stronger than a magnet of the same size made of one part. Acting on this theory, each bar of a Chicago bridging generator is made up of three separate magnets. Thus the Chicago five-bar bridging generator No. 1 has fifteen separate magnets placed in three rows of five each. Comparatively small magnets can be tempered more uniformly and thoroughly saturated with magnetism than comparatively large ones. The "Chicago method" employs small magnets, but in the aggregate the magnets used on a



CHICAGO BRIDGING GENERATOR NO. 2.

five-bar Chicago generator will, it is claimed, weigh more than the magnets used on any other style of bridging generator.

Chicago six-bar bridging generator No. 2 is similar to the No. 1, except it has eighteen magnets placed in three rows of six each. The Chicago Telephone Supply Company states that these two generators will ring more bells than any other bridging generators, without exception. An illustrated folder has been issued by the company setting forth the advantageous features of the "Chicago method," which will be mailed to telephone men upon request.

CABLE TESTING APPARATUS.

Mr. James G. Biddle, Stephen Girard building, Philadelphia, has received orders for cable testing equipments from such prominent companies as the Bell Telephone Company of Philadelphia, Keystone Telephone Company, Philadelphia, Interstate Telephone Company, Trenton, N. J., Reserve Construction Company, Cleveland, Ohio, and the Pittsburg and Allegheny Telephone Company, Pittsburg, Pa. All of these outfits included one or more of the Fisher cable testing sets, which have practically come to be considered as standard apparatus for this class of work. The Fisher sets are made by Messrs. Leeds & Co., for whom Mr. Biddle is sole selling agent. By addressing him interested parties can secure a copy of catalogue 360 without charge. It describes the Fisher sets in detail, as well as accessory apparatus.

TELEPHONE CONSTRUCTION COMPANY ENLARGING ITS SCOPE.

At the annual meeting of the stockholders of the Continental Telephone Construction Company, held December 9, the company amended its charter to include, with telephone work, the building of electric light plants, electric railways and general engineering and contracting work.

The board of directors was increased from three to five. All the officers were re-elected: William Passow, president; Paul M. Krahmer, vice-president and general manager; F. B. Paten, secretary; John C. Leppert, treasurer. The company is making a specialty of telephone work and is in position to finance companies having good franchises.

A BLIND TELEPHONE OPERATOR.

Miss Abbie Downing of Metcalf, Edgar County, Illinois, is the only known blind telephone operator in the country. She is a prodigy. Not only can she attend to the many duties of the telephone exchange, with a skill and rapidity rarely equaled by an operator blessed with sight, but is singularly versatile in accomplishments. Although blind since an infant of two years, she does all the things that a bright girl with two good eyes can do, and can do them well. She has done the household cooking in her father's home for years. She also sews by hand and on the machine and does fancywork that is beautiful in design. She is also a musician and has not only appeared in public, but has taught music. But her work as a telephone operator is her most wonderful accomplishment. Mr. George W. Fair, who is interested in a number of telephone exchanges in Edgar County, secured Miss Downing a position in the Metcalf exchange. Mrs. A. R. Wetz was her instructress, and at the end of the first day she was able to operate the exchange without aid, and at the end of the third day she was placed on duty permanently and assigned to the day shift. Officials of the company say they never had a better operator, and patrons who use the lines say that no operator on the system makes the connections more promptly or is more pleasant than the blind girl operator. The Metcalf exchange operates over sixty telephones, besides the work at the toll board. Two operators handle the work and Miss Downing is in charge alone at certain hours. She locates a call instantly by the sound of the "drop," or, if busy, and she fails to hear the warning click, by hastily passing her nimble, sensitive-tipped fingers over the board. The plug for connection she thrusts into the proper place with instantaneous precision. No matter how speedily the calls follow each other, she never becomes discomposed. Miss Downing was born April 23, 1870. When two years old an affliction of the eyes bereft her of sight. When she was three years old her parents moved from Edgar County, Illinois, to Park County, Indiana. She was educated at the Institute for the Blind at Indianapolis, graduating June 14, 1892. Her course included scientific studies. In addition she took special courses in music, elocution and fancywork. Mrs. Wetz, who instructed Miss Downing in the mysteries of the telephone exchange, says she has taught several persons to operate the system, but none proved as apt as the blind girl. "She is a faithful worker and worthy woman. Her disposition is sunny and temperament genial."

"You are publishing a very satisfactory paper and are still improving.

Jerseyville Telephone Co.

POWER PLANTS FOR RELAY SWITCHBOARDS.

Since the first introduction of the battery telephone there has been constant effort on the part of inventors to centralize all the batteries used for talking. Many schemes were evolved for this purpose, as reference to the Patent Office records will clearly show. The general practice, however, up to about the middle of the last decade, was to use local transmitter batteries and magneto calling apparatus. Along about 1895 the common battery board commenced to be generally used in practice. It is really returning to the first principles of telephony; that is, a battery cell and centralized batteries for transmitters.

The successful introduction of the common battery system is undoubtedly due to the perfection of the storage battery and the perfection of machines for charging the same. It is a fact well known that in order to supply a number of transmitters from one battery without having cross talk, that battery must have the lowest possible internal resistance, and the perfected storage battery possesses this feature of extremely low internal resistance. In the common battery system as used to-day current is supplied to the subscriber's transmitters, to the operator's transmitters, to all the different relays and lamps, from one centralized storage battery.

The first common battery systems were equipped on the multivolt plan, that is, 20 volts for operating subscribers' transmitters, 8 volts for operating relays and lamps and 4 volts for operators' transmitters and lamps. In the last year or two the apparatus has been so perfected and arranged as to allow the use of but a single set of batteries operating at 24 volts. Not even a duplicate set of batteries is required, for, because of the peculiar construction of the charging dynamos and the insertion of choke coils in the charging circuits, it is possible to charge and discharge the batteries at the same time without making the lines noisy.

On account of the inability to manufacture lamps which would operate satisfactorily on a potential varying from 22 to 28 volts, it was necessary until recently to resort to the use of an end cell which could be switched in or out at will. Recent improvements in lamp manufacturing have permitted the disuse of the end cell, for lamps are now made which will operate satisfactorily on a potential varying from 22 to 28 volts.

As brought out above, the vital point in common battery transmission is the low resistance of the batteries. If this were not the case cross talk would be produced on all lines because of the variation of the potential difference over the terminals of the battery. The Hayes system of split repeating coils is used now almost universally with the common battery system.

Since the batteries are the very soul of the relay telephone exchange every possible precaution must be taken to provide them with charging current at all times. Therefore, in designing a power plant for a relay system the question of power supply should receive careful study and that power selected which is, first, most reliable, and, second, most economical.

PRIMARY SOURCES OF POWER.

The primary sources of power usually obtainable may be classed as follows:

(1) Electricity—
110, 220, or 500 volts direct current.
104 volts, single phase, 133 cycle, alternating current.
104 volts, single phase, 60 cycle, alternating current.
204 volts, two phase, 60 cycle, alternating current.
204 volts, three-phase, 60 cycle, alternating current.

(2) Gas—
Illuminating gas.
Producer gas.
Gasoline.
Kerosene.
Natural gas.

(3) Water—
Wheels of the jet type, such as the Pelton, American Impulse and Leffel Cascade can be used where the water pressure exceeds fifty (50) pounds to the square inch.

(4) Steam—
Any ordinary form of steam engine with an automatic shaft governor.

The most desirable electric power for operating motors connected to charging machines is a 220-volt direct current circuit, which has but a slight voltage fluctuation. Five hundred-volt circuits are used in a great many cities for power purposes and are generally reliable. This power should not be used if street cars are run off the same circuit, or if the dynamos operating street cars are run off the same countershaft as the machines used for generating the 500-volt power current. If direct current cannot be obtained a single phase, two phase or three phase alternating circuit should be used. Motors are now manufactured which operate satisfactorily on any of these phases and also at a high efficiency. But one source of power should be used from one electric station, for, obviously in case of fire all circuits would be out. As two sources of power should be available for charging purposes a gas or steam engine must be used, if it is not possible to obtain two sources of electric power from two different stations.

Next to electric power, power obtained from a gas engine is most desirable. If gas is not available, gasoline can be used. Engines are also manufactured which use kerosene for fuel, but have not come into practice for charging machines in telephone exchanges. Water motors might be used for charging purposes where a sufficiently low rate can be obtained and where the water pressure is steady. Wheels of this kind should be so designed that the peripheral speed of the buckets equals one-half of the velocity of the impinging jet to obtain maximum efficiency. When in use the belting should be so arranged as to procure this condition. Steam engines are ordinarily not used for the running of charging dynamos direct, but are usually connected to an engine supplying lights and power for an exchange building and the charging motors are run from these power mains.

For the proper handling of the various circuits the power switchboards are generally divided into motor panels, generator panels and fuse panels.

In addition to the regular volt meters and ammeters I think that the switchboard should be provided with watt meters in the motor circuit and in the charging and discharging circuits. It would then be possible, at all times, to know the exact efficiency of the power plant and to immediately remedy any defects. The very best apparatus obtainable is none too good for the power plant of a modern relay telephone switchboard.

The storage battery claims such a vital part in the operation of the common battery system that I think it advisable to make a few remarks upon its theoretical operation, and incidentally to give the results of some personal experiments.

The storage battery consists of a number of lead plates in a dilute solution of sulphuric acid, H_2SO_4. Half of these plates are joined together and called positive plates and the other half are joined together and called negative plates. When a storage battery is fully charged there is on the surface of the positive plate a thick coating of lead peroxide, PbO_2, and the surface of the negative plate is converted into a spongy lead, Pb. During the discharge both electrodes are converted into lead sulphate, $PbSO_4$, by the extraction of sulphion from the electrolyte, thus reducing the density of the solution. The chemical reaction may be represented by the following equations:

$PbO_2, H_2SO_4, Pb SO_4, H_2, O, O,$
$Pb O H_2, SO_4, Pb SO_4, H_2, O,$
or, putting both equations together,
$PbO_2, H_2SO_4, Pb, Pb, SO_4, 2H_2, O, Pb, SO_4.$

The recharging of a cell is practically the transference of oxygen from the negative plate to the positive plate. In discharging, the action of the positive plate is supposed to take place in two stages: 1st, reduction of the peroxide to monoxide, and then the conversion of the monoxide to lead sulphate. On charging the action is reversed, the sulphate being converted into peroxide on the positive plate. The point might be brought up that there would be local action between the lead peroxide on the positive plate and the supporting lead grid on the plate itself. Such action does undoubtedly take place, but a thin layer of lead sulphate will form between the lead peroxide and the lead plate which, because of its insolubility and relatively high resistance, prevents further local action.

It has been observed that the voltage of a cell when charging is always higher than on discharging, even when full allowance is made for the voltage drop, due to the internal resistance of the cell. This shows conclusively that the chemical reactions of the charge are not the reverse of those on discharge; for if they were the voltage on charge and discharge would be equal.

Another point which has been observed is that the internal resistance of a storage battery is some function of the current. When the rate of discharge is high, the internal resistance of the cell is low and vice versa. Consequently it would naturally be expected that as the amount of current drawn from the storage battery decreases that the voltage would drop, due to the fall of potential over the increased resistance of the battery. Such, however, is not the case, as I chanced to discover in an efficiency test on the Dallas plant. As the rate of discharge became less the voltage rose, which proves conclusively that the voltage is also some function of the discharging current and is independent of the internal resistance. This will be described more in detail under the head of "Efficiency Test."

In charging storage batteries, the current at the beginning of the charge should not be too great or considerable energy will be lost, due to the internal resistance of the cell, which is highest when in a discharged state, as the acid is then out of the solution and in the plates. Too low a charging current is also detrimental, for it tends to produce a layer of white sulphate over the plates, which completely resists further electrolytic action and lowers the capacity of the cell. Generally speaking a cell should never be charged at less than one-tenth (1-10) of its normal rate. Buckling is generally due to too high a charging current and too high discharging current, which makes the plates expand unevenly.

Lately experiments have been made in the use of rectified alternating current for charging storage batteries, and with gratifying results. It seems that the peculiar character of the current hastens electrolytic action.

As explained later under the head of "Instructions," a cell should never be allowed to discharge below 1.8 volts. The reasons for this are as follows: First. The regulation is troublesome. Second. Efficiency is low. Third. Dangerous molecular changes take place in the interior of the cell. Fourth. Plates with uneven amounts of charge discharge into one another. Fifth. Life of the battery is considerably shortened. If the voltage of any one cell in a series is allowed to fall to 0, which might be caused by a short circuit, and the other cells continue to be discharged, the exhausted cell will reverse its polarity. This is because it is charged in a reverse direction by the current from the other cells and the positive plates become negative, and vice versa.

It has been attempted to use some other material than lead for storage batteries, but lead alone of all the metals forms a sulphate which is insoluble in sulphuric acid and unacted upon to any extent. This sulphate between the active material and the grid almost entirely prevents local action and the consequent rapid destruction of the cell. Claims of an efficiency of eighty (80) to ninety (90) per cent have been made for storage batteries, but it is probable that the average commercial efficiency does not exceed seventy-five (75) per cent.

The losses in the cell may be classed as follows: First. Direct losses due to heat. Second. Losses due to local action between supporting grid and active material itself. Fourth. Losses due to unreserved chemical action; that is, the production of hydrogen, oxygen, ozone and hydrogen peroxide. The last two losses are the most serious.

When a battery is to stand for any length of time it should be fully charged and not discharged any. When the cell is fully charged there is a film of peroxide over the entire positive plate, which thus prevents local action between the active material and the lead supporting plate. If the cell should be discharged slightly this film of peroxide on the lead supporting grid would be destroyed and there would be a chance for local action between this lead grid and the active material.

Some very interesting phenomena were observed in relation to the voltage between the different elements and the lead linings of the cells. These experiments were conducted upon the main battery at the Dallas exchange. The following are some of the results:

The voltage between the lead linings of the different cells is equal to the voltage of the cells. The voltage between the positive plate and the lead lining is, when fully charged, 1.4 volts positive. When the cell is discharged down to two volts, potential is 1.35 volts positive. Voltage between the negative plate and the lead linings is .7 volt negative and .65 volt negative respectively when the cell is fully charged and discharged to two volts. Thus the sum of the voltage between the elements and the lead lining is always, under normal conditions, equal to the voltage of the cell. This is probably due to deformation of some of the higher forms of sulphate on the lead lining. It is curious to note in this respect that 1.4 volts is the difference of potential required to decompose water. The voltage between the ground and the lead lining of the first cell is 1.4 positive and 2 volts to 2, to 2.1 volts is added for each additional lining. Thus the voltage between the ground and the lining of cell No. 3 would be, under normal conditions, 5.5. If now we ground the lining of the cell through a low resistance a heavy current would flow. Large amounts of hydrogen and oxygen gas are generated and a strong odor of sulphur is noticed.

Supposing that the No. 3 cell was grounded and its voltage to earth initially was 5.5 volts. Immediately after the above current has passed it will be noticed that the voltage has fallen to 4.1. This is explained on the supposition that the highest sulphate lead on the lead lining is electrolized into a film of peroxide of lead and is therefore at the same potential as the positive plate in the No. 3 cell, or, in other words, it is equal to the voltage of the two cells. If the voltage between the positive plates and the lining is now measured it will be found to have fallen to 0, and the voltage between the lead lining and the negative plate is 2.1 volts positive.

An important result is drawn from the above experiment. If the lining of a cell, or the wood casing, which is damp, becomes grounded, current will flow and in a short time the lead lining will be eaten up by electrolysis, or in other words the lining will be rotted into lead peroxide.

Above it was shown that the cell in normal condition measured 1.4 volts positive between the positive plate and the lead lining and .7 of a volt negative between the lead lining and the negative plate. Therefore, if a cell is grounded, the voltage between the positive plate and the lead lining will be considerably less than 1.4, and between the lining and the negative plate more than .7 volts, depending upon the rate of action. This will be true even though the lead lining is grounded through a high resistance, as was conclusively shown by experiments.

(Continued.)

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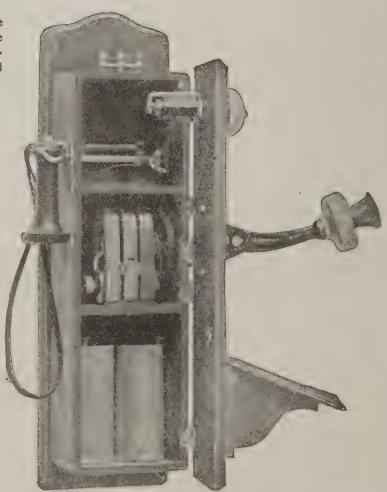

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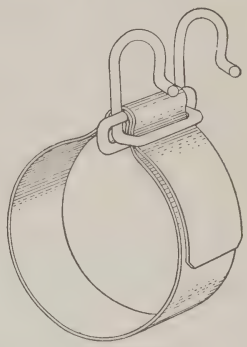

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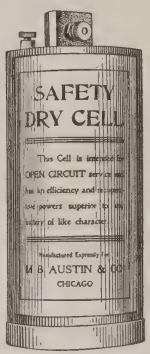

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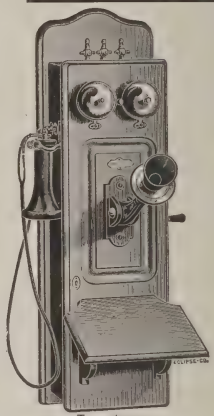

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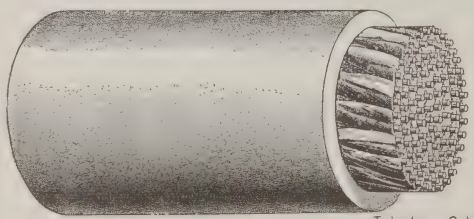

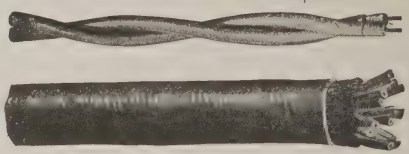

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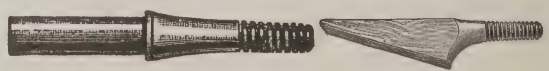

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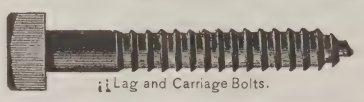

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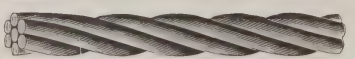

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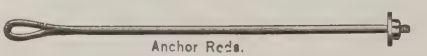

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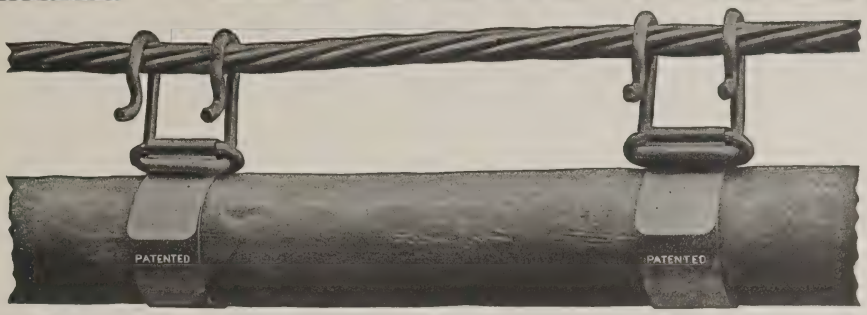

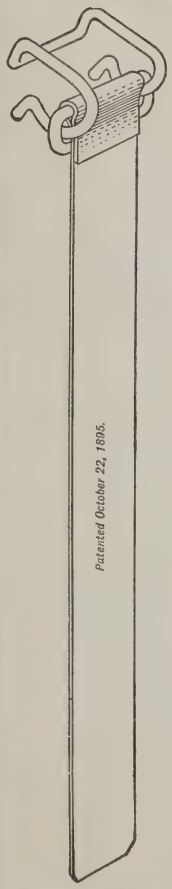

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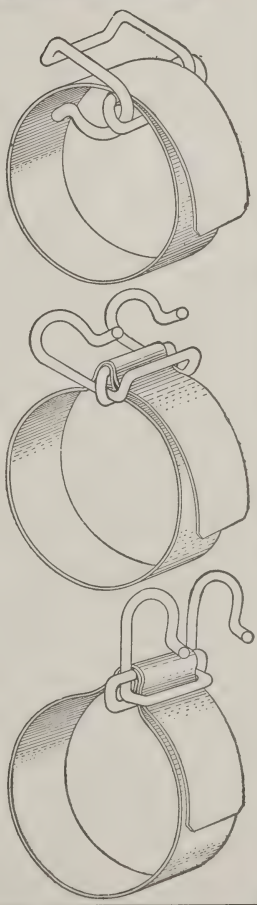

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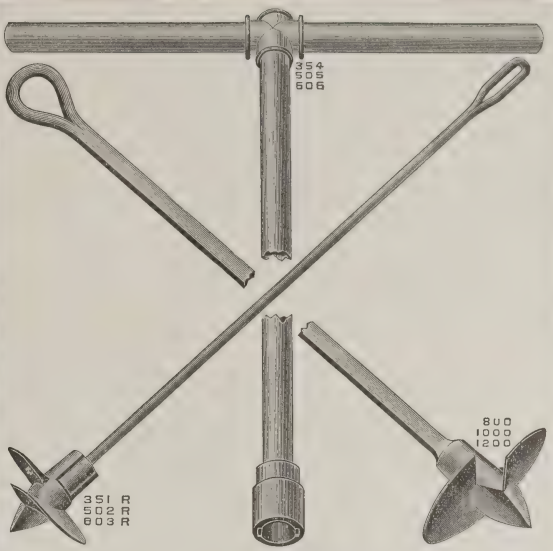
Write us for Particulars and Prices.

W.N. MATTHEWS & BRO.
DISTRIBUTORS
505 Carleton Bldg., ST. LOUIS.



THE WRENCH
MUST NOT BE FORGOTTEN WHEN ORDERING 351R, 502R AND 603R.

YELLOW PINE CROSS ARMS

We are manufacturing cross arms from the high grade long leaf yellow pine of central Mississippi and our shipping facilities are the best in the state. You will find both prices and goods right. Write us.

Brownlee Lumber Co., Meridian, Miss.

JOHN H. FOWLER
FISHER BUILDING,
CHICAGO.
CEDAR POLES
LARGE STOCK.
PROMPT SHIPMENTS.
LONG POLES A SPECIALTY.

MICHIGAN WHITE CEDAR POLES

A large assortment, all sizes.
We are making very attractive prices on a large stock of 25 foot 5 and 6 inch top, 30 foot 7 inch top and up.
Orders Filled Promptly in Carload Lots. Correspondence Solicited.
Write to Escanaba, Mich. office for prices.
Kellogg Switchboard & Supply Co.,
Congress and Green Sts., CHICAGO, ILL.

WE HAVE 30,000 POLES

In stock ready for IMMEDIATE SHIPMENTS. All sizes 5 in. 20 ft. Poles and larger, quick delivery from our Central Yards. Eleventh year in the Pole business.
O. W. SMITH, Temple Court Building, CHICAGO.

W. C. STERLING & SON,
MONROE, MICH.
11 POLE YARDS IN MICHIGAN.
WHOLESALE PRODUCERS FOR 20 YEARS.
CEDAR POLES

Cedar Lindsley Brothers Company
MENOMINEE, MICH.
YARDS:
Menominee, Mich. Stephenson, Mich.
Goll, Wis. Portland, Ore.
Poles

J. C. HUEBEL & CO.,
MENOMINEE, MICH.
OUR STOCK OF POLES IS COMPLETE.
MAIN YARD AT
MENOMINEE.
BRANCH YARDS AT
WAUSAUKEE AND PACKARD, WIS.
NATHAN AND BAGLEY, MICH.

TELEPHONE POLES
FIRST-CLASS STOCK;
LARGE ASSORTMENT.
WRITE FOR PRICES.
F. N. CARROLL, TRAVERSE CITY, MICH.

CEDAR
PITTSBURG & LAKE SUPERIOR IRON CO.,
PRODUCERS AND WHOLESALERS,
ESCANABA, - - - MICH.
POLES

CEDAR POLES

THE MORSE CEDAR CO.
Successors to The Porter Morse Co.
PRODUCERS.
PRINCIPAL OFFICES:
SAGINAW, - - - MICH.

CEDAR POLES

I HAVE IN STOCK FOR IMMEDIATE SHIPMENT.

300	7-inch	25-foot	Cedar	Poles	at	-	-	$1.20
300	6 "	25 "	"	"	"	-	-	1.10
400	5 "	25 "	"	"	"	-	-	.70

F. O. B., CHICAGO.

The stock will not last long at these prices. You had better order to-day.

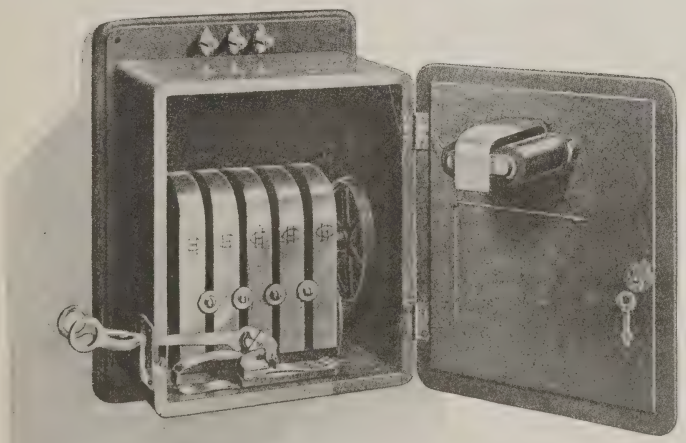
F. E. BELL, DES PLAINES, ILL.

POLES

Our stock in 25 foot, 5, 5½, 6 and 7 inch tops and 30 foot, 5, 6 and 6½ inch top is especially large just now, although we carry all the standard sizes.

The number of our customers is always increasing and we never lose an old one. A general satisfaction prevades the whole deal when you order from us. Just try it once.

MALTBY LUMBER CO., BAY CITY, MICH.



"WHAT'S THE USE"

TRYING TO GET SOMETHING

FOR NOTHING ?

OUR GENERATORS

ARE BUILT ON HONOR, ARE TIME TRIED AND ARE THE

STANDARD

TO-DAY AS ALWAYS.

WHY NOT BUY THEM

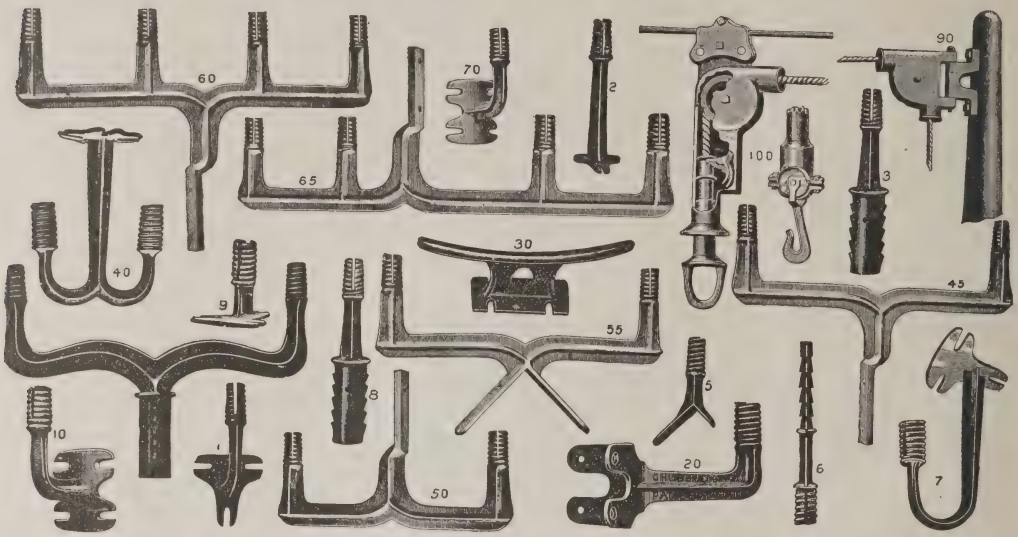
INSTEAD OF EXPERIMENTS ?

HOLTZER-CABOT ELECTRIC CO., 397 Dearborn St., Chicago, Ill.

HOME OFFICE AND FACTORY: BROOKLINE, MASS.

Please tell the Advertiser you saw his Announcement in TELEPHONY.

Electrical Construction Supply Company, Springfield, Ohio.



Sole manufacturers of the "Chubbuck Patent" Malleable Iron Brackets, Pins and Break Arms. They all have the Screw End and Double Slotted Head, and will not break the insulators by changes of hot and cold weather. Greatest amount of strength with least material. All the leading Electrical Supply Houses handle our goods. Our illustrated circular describes them in detail. Try our New Automatic Suspension Pulley. It is strictly Automatic.

INDEPENDENT TELEPHONE SUPPLY COMPANY

TELEPHONE CONSTRUCTION SPECIALTIES
AND SUPPLIES

19 SOUTH CANAL STREET, CHICAGO

COMPLETE STOCK *PROMPT SHIPMENTS*

WE HAVE A LARGE STOCK OF **WIRE** GENUINE DBLE. GALVANIZED

"EXTRA B. B.," "B. B." AND "MONARCH."

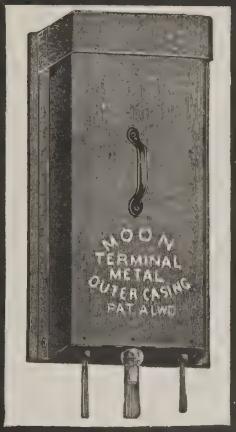
Hard Drawn Copper Wire. *Galvanized Steel Strand.*

"Boston" Cable Hangers, "Crosby" Clips.

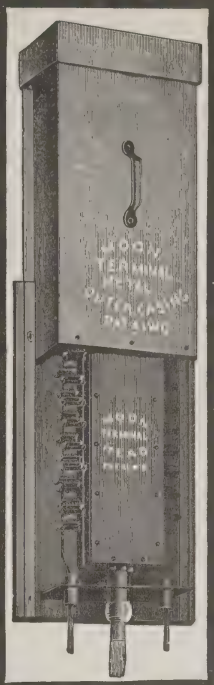
Complete Stock of Telephone Construction Material.

Net Price List Upon Application.

Moon Terminal Head



The Moon Terminal Head, with Metal Outer Casing, showing that it is possible to place The Moon Terminal Head at any desired place on the pole, to advantage, owing to the fact that the door for outer Casing slides.



The Moon Mfg. Co.
43-49 S. Canal Street, Chicago.

NEW STANDARD DRY BATTERY.

ABSOLUTELY HIGHEST STANDARD in the world for Telephone work. My No. 5 Cell, **U. S. NAVAL STANDARD** for nearly 4 years, will be good enough for you, no matter how exacting you are.

Complete catalogue for the asking.

WILLIAM ROCHE,

INVENTOR AND SOLE MANUFACTURER,
42 Vesey Street, New York City.

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NO DEAD ONES

THERE IS ONLY ONE WAY

No. 6.

to increase your earnings and that is by using.....

Measured Service

AND

Pay Stations

No. 7.

OUR LINE INCLUDES 7 DIFFERENT STYLES. WE LEAD—OTHERS FOLLOW.

THE AMERICAN TOLL TELEPHONE CO., 43-47 Sheriff St., CLEVELAND, O.

JOHNSTON & DEAN,

Wainwright Bldg.,
ST. LOUIS, MO.

TELEPHONE ENGINEERS.

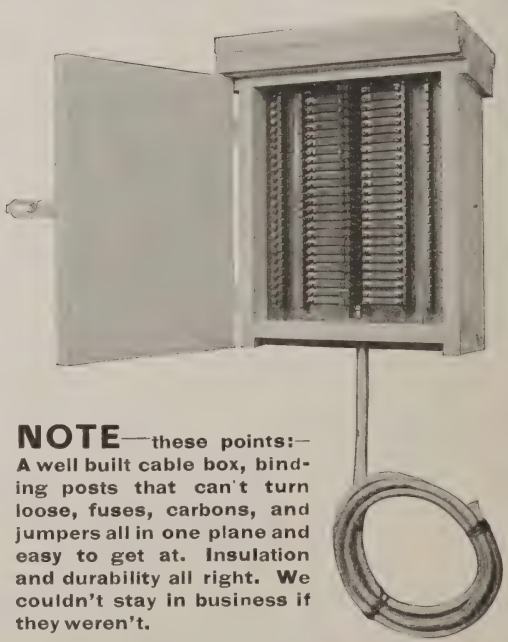
CONTRACTORS FOR
COMPLETE INSTALLATIONS.

Plans and Estimates Furnished on Short Notice.

MANUFACTURERS OF

THE J&D TERMINAL

and other up-to-date construction appliances.



NOTE—these points:—
A well built cable box, binding posts that can't turn loose, fuses, carbons, and jumpers all in one plane and easy to get at. Insulation and durability all right. We couldn't stay in business if they weren't.

NO. 45. BRIDGING.

MODERN

HEAVY BRIDGE TELEPHONE.

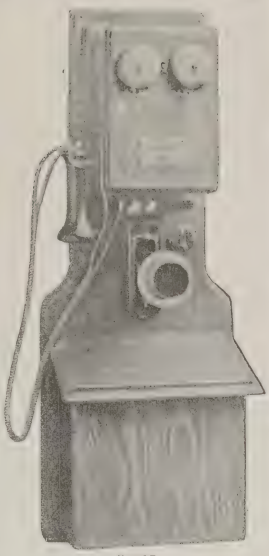
Our phones work well on heavily loaded lines — have the best workmanship and are the prettiest instruments on the market.

TELEPHONES SENT ON TRIAL.

THE MODERN TELEPHONE CO.

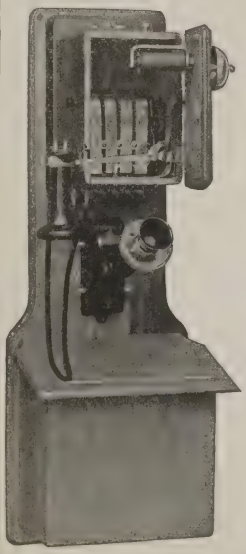
MAIN OFFICE: 1106 E. 10TH ST.,

INDIANAPOLIS, IND.



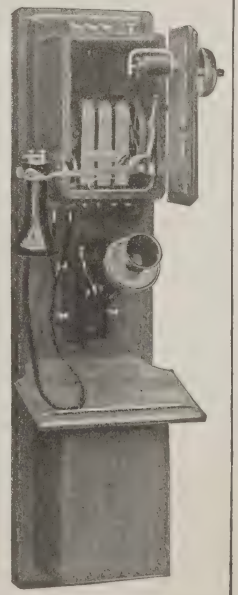
No. 37.

TELEPHONE APPARATUS, SUPPLIES AND ACCESSORIES.



Latest Types and
Most Improved
Telephone Apparatus
on the Market.
Best Quality in Everything.

CONSTRUCTION MATERIAL.



Central Telephone and Electric Co.

909 MARKET ST., ST. LOUIS, MO.

WRITE US. WRITE US.

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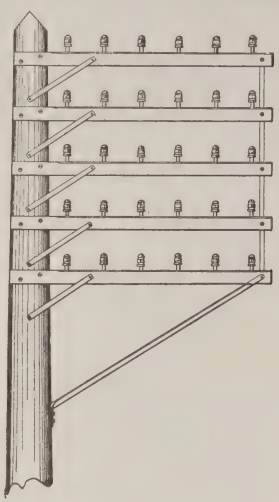
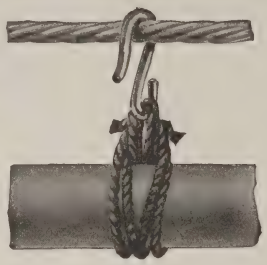
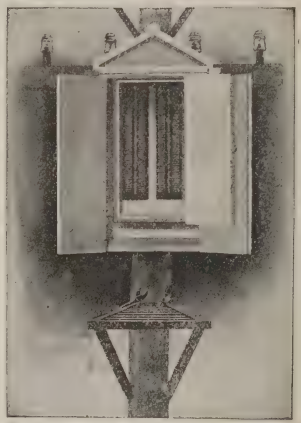
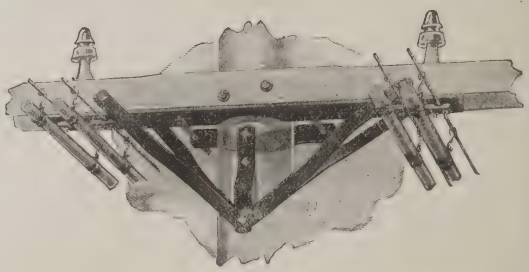


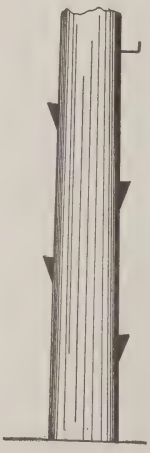


MARLINE CABLE HANGERS.
DISTRIBUTING PANELS.
CROSS CONNECTING PANELS.

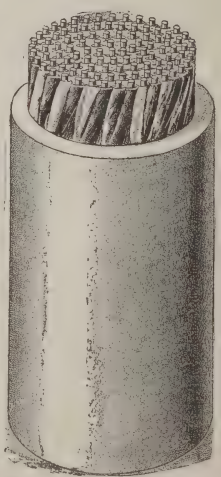


ANGLE IRON CABLE ARMS.
ALLEY BRACES FOR SIDE ARMS.
BRACES FOR DOUBLE ARMING.
CABLE POLE HOUSES.
CABLE POLE SEATS.
POLE STEPS.





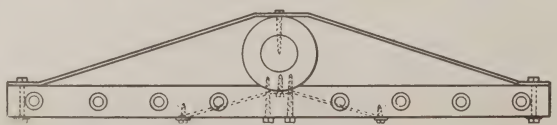
TROLLEYS FOR STRINGING CABLES.
RODS FOR FISHING CONDUITS.
NATIONAL CABLES AND EXTRA QUALITY DUPLEX.



THE F. BISSELL CO.,

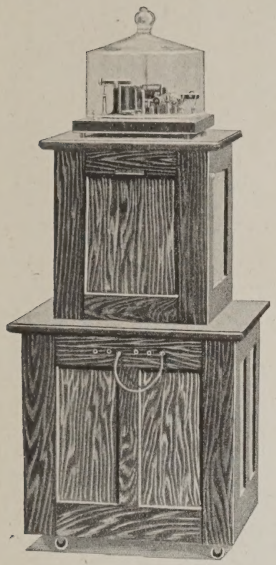
WHOLESALE ELECTRICAL SUPPLIES,

114-116 St. Clair St., TOLEDO, O.



WARNER SWITCHBOARD { POWER GENERATOR

IS ENTIRELY AUTOMATIC.
REQUIRES ABSOLUTELY NO ATTENTION.



DRY BATTERY OUTFIT COMPLETE.

SAVES { TIME. MONEY. NERVES. RESULTS { BETTER SERVICE. SATISFIED CUSTOMERS. INCREASED BUSINESS.

COST FOR BATTERY RENEWALS LESS THAN 25c A MONTH PER 100 SUBSCRIBERS.

Cheapest Power on Earth. With Our Power Generator You Can Use Less Operators.

LISTEN { NO BELTS TO BREAK. NO BEARINGS TO OIL. NO POWER BILLS TO PAY. NO MORE GENERATORS TO BUY.

YOU RUN NO RISK. "GUARANTEED."

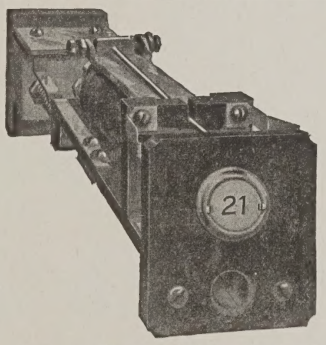
ENTIRE SATISFACTION OR NO PAY.

IT WILL DO YOUR RINGING UNDER ALL CONDITIONS 24 HOURS A DAY. PRODUCES PULSATING CURRENT FOR SELECTIVE SIGNALS—ALSO ALTERNATING CURRENT.

MANUFACTURED EXCLUSIVELY BY

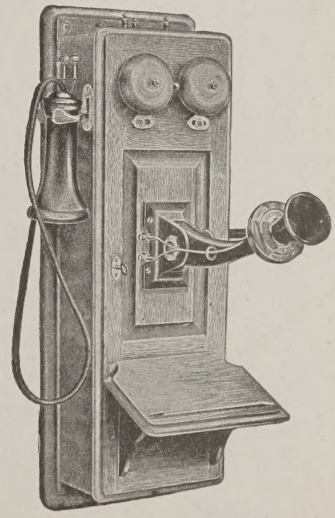
WARNER ELECTRIC CO., Muncie, Ind.

Mason Bi-Polar Receiver.
All metal parts concealed.



Front view "Bull's-eye" drop with patented inwardly falling, self-restoring shutter.

Sumter Apparatus is strictly high-grade. Sold on its merits and guaranteed. Write us for description and prices.



No. 50. "New Beauty."
Pleasing in appearance. Perfect in service. All parts easily accessible and interchangeable.

The Sumter Telephone Mfg. Co.

R. M. WALLACE, President. C. T. MASON, Vice-President. **SUMTER, S. C.** F. C. MANNING, Secretary. C. G. ROWLAND, Treasurer

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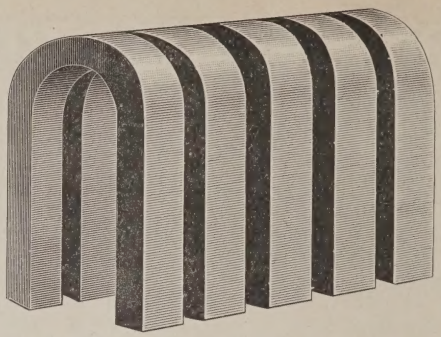
CHICAGO TELEPHONES SATISFY

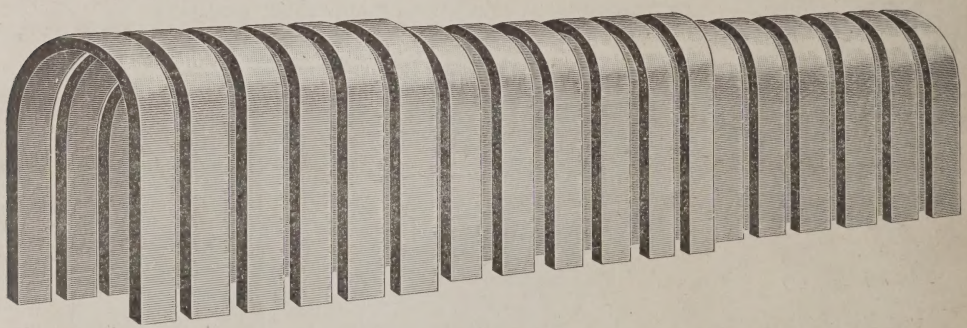
The illustration shown herewith represents the five magnets used on the most powerful generator made by any other factory.



CHICAGO TELEPHONES SATISFY

The second illustration represents the eighteen magnets used on

Chicago Six=Bar Bridging Generator No. 2.



The Chicago method secures the entire benefit of lamination and uses more magnet steel than is used on any competing generator. Each bar consists of three separate magnets and weighs more; is longer, is more uniformly tempered and more thoroughly saturated with magnetism than the bars used on any other Bridging Generator. Comparatively small magnets can be tempered more uniformly and more thoroughly saturated with magnetism than comparatively large ones. A generator bar made up of many small similar magnets is stronger than a generator bar of the same size made of one piece. That is what is meant by the benefits of lamination.

A folder has been issued explaining the advantage of

THE CHICAGO METHOD

of constructing Bridging Generators. Copies will be mailed to any reader of Telephony upon request. We have issued a new edition of the Bridging Book. If you haven't received a copy please write us to send you one. It is too expensive to mail indiscriminately, but we gladly send it to any one who is interested.

CHICAGO TELEPHONES SATISFY

Chicago Telephone Supply Co.,

THE GREAT MAIL ORDER FACTORY,

133-135-137-139 South Clinton St., Chicago, U. S. A.

CHICAGO TELEPHONES SATISFY

Please tell the Advertiser you saw his Announcement in TELEPHONY.

INDEPENDENT
LOCAL AND LONG DISTANCE
TELEPHONE

AMERICAN ELECTRIC TELEPHONE CO

CHICAGO

AUTHORIZED CAPITAL THREE MILLION.

LARGEST MANUFACTURERS IN THE WORLD.

WRITE FOR CATALOGUES.

The California Limited

New features this season—Daily service and extension to San Francisco.

Drawing-Room Pullmans, Buffet Smoking Car (with barber shop), Harvey Dining Car, Observation Car (with ladies' parlor).

Wide-vestibuled, electric-lighted and luxuriously equipped.

From Chicago to Los Angeles and San Francisco daily

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CHICAGO.

C. A. HILPERT President.
C. W. CHANDLER, Treasurer.

Continental Telephone Construction Company

GENERAL ELECTRICAL ENGINEERS AND CONTRACTORS.

Telephone, Electric Light, Street Railway.

WE BUY FRANCHISES, FINANCE COMPANIES AND CONSTRUCT ELECTRICAL PLANTS OF ALL KINDS.

EPHONE WORK A SPECIALTY. MARQUETTE BLDG., CHICAGO.

JONES & WINTER,

INDEPENDENT

Telephone Engineers and Contractors,

1259 MONADNOCK BLDG., - - CHICAGO, ILL.

WRITE FOR OUR REFERENCES.

W. H. CRUMB & COMPANY

ENGINEERS—CONTRACTORS

Telephone Engineering and Construction

1211 MONADNOCK BUILDING,
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w York, 56 Liberty St. Boston, Tremont Building. Philadelphia. Pittsburg. Chicago. San Francisco.

STANDARD FIBER PAPER RUBBER CABLES UNDERGROUND TIPTOP STERLING ECLIPSE RUBBER WIRES CABLE HIGH-GRADE WEATHERPROOF WIRES CO.

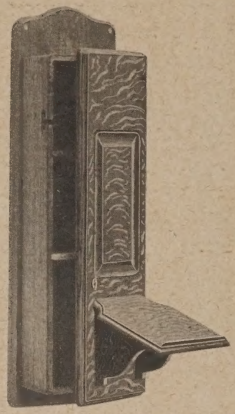
Enquire about the work we have done, and the thousands of miles of cables (Aerial and Underground) we have furnished and installed for Electric Railway, Electric Light, Telegraph, Telephone and other Companies. The replies will interest you.

THE M. S. HUEY CO.,

INDIANAPOLIS, IND.

Manufacturers of

Telephone Cabinet Work

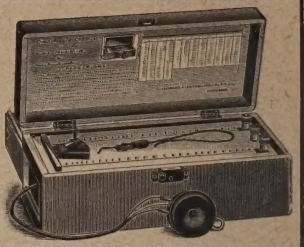


Switchboards,
Magneto Boxes,
Bridging Boxes,
Series Boxes,
Backboards
and
Wall Cabinets.

WHEN IN THE MARKET FOR CABINET WORK WRITE US.

You need it.

It will save you money.



Our Direct Reading Ohmmeter

THE PRICE IS RIGHT.
All supply houses sell it.
You should know more about it.
Send for descriptive circular.

Illinois Electric Specialty Co.

1203 Marquette Bldg.
CHICAGO.

WE MAKE 'EM

at factory,
Chattanooga, Tenn., U. S. A.
Below find price list of

TELEPHONE ARMS,

F. O. B. FACTORY.

Write for prices, delivered anywhere.

Prompt shipments always.

NAME OR CODE WORD	NO. PINS	LENGTH	SPACINGS			PRICE.
			END	Center	SIDES	
Dennis	2	2 ft. 8 in.	3	26		9 cts.
Derby	4	3 " 6 "	3	16	10	11 "
Dexter	6	5 " 2 "	3	16	10	15 "
Dryden	8	6 " 10 "	3	16	10	21 "
Dundee	10	8 " 6 "	3	16	10	26 "
Duston	12	10 ft.	3	14	10	30 "

When ordering, use Name or Code Word and avoid any possibility of mistakes.

Central Manufacturing Co.

CHATTANOOGA, TENN., U. S. A.

BAINES' PRIMARY BATTERY

FOR SWITCHBOARD AND CENTRAL OFFICE TRANSMITTER WORK.

FOR ANY PURPOSE REQUIRING A CONSTANT CURRENT.

Maintains the Voltage for Over 100% Longer Time than Ordinary Gravity Battery.

Any Ordinary Gravity Battery may be converted into the Baines' Battery without any change in the form of Jars or Zincs now in use, by the addition of a Baines' Battery Grid.

BATTERY SUPPLIES OF ALL KINDS.

THE PAN-AMERICAN CELL FOR OPEN CIRCUIT WORK.

CIRCULARS ON APPLICATION.

IMPROVED PRIMARY BATTERY CO.,

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